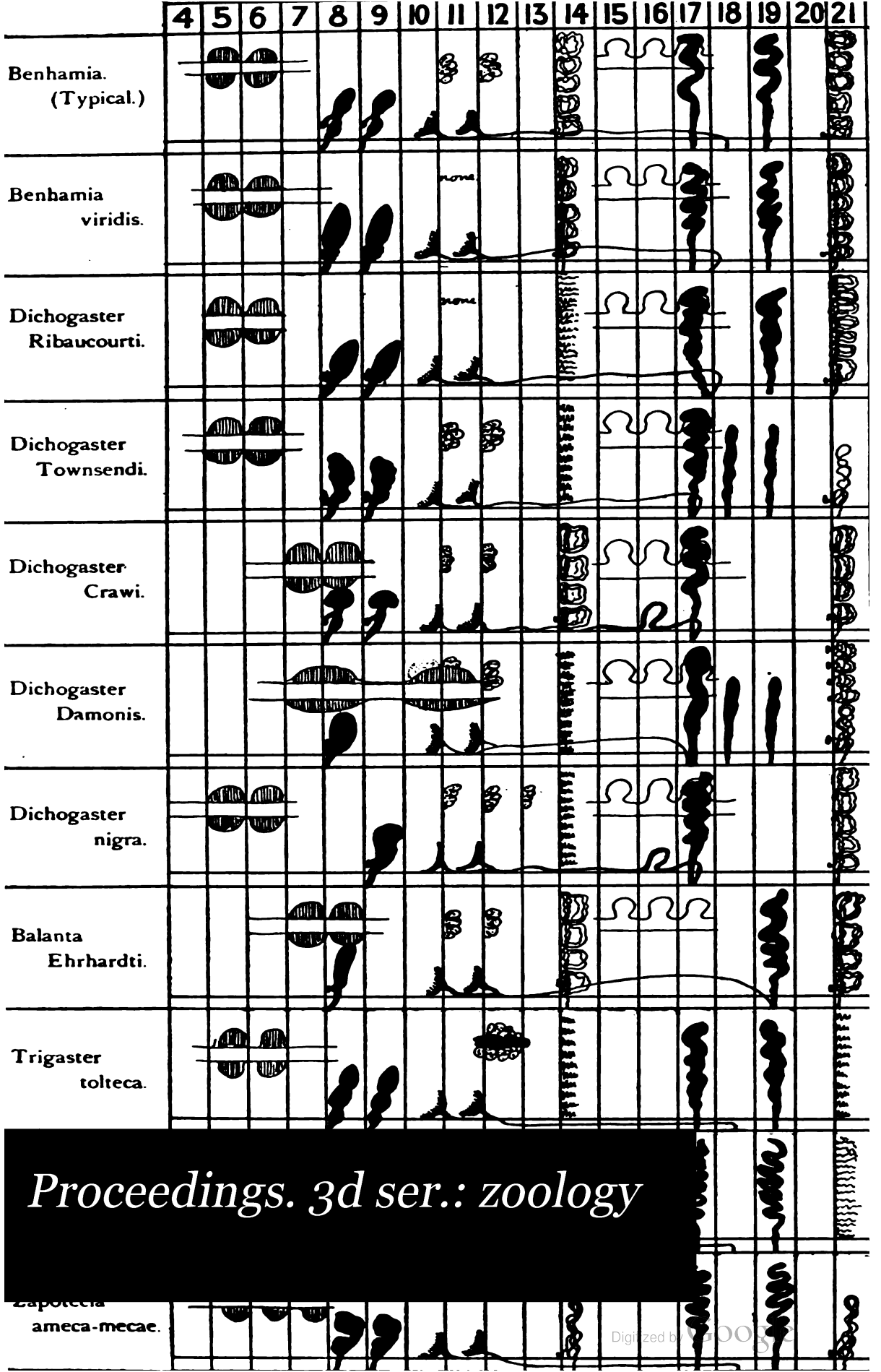


PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES.

THIRD SERIES.

ZOOLOGY. VOL. II, No. 2.

Researches in American Oligochæta, with Especial Reference to those of the Pacific Coast and Adjacent Islands.

BY

GUSTAV EISEN, PH. D.,

WITH TEN PLATES.

Issued January 20, 1900.

SAN FRANCISCO:

PUBLISHED BY THE ACADEMY.

1900.

RESEARCHES IN AMERICAN OLIGOCHÆTA, WITH ESPECIAL REFERENCE TO THOSE OF THE PACIFIC COAST AND ADJACENT ISLANDS.

BY GUSTAV EISEN, PH. D.

CONTENTS.

PLATES V–XIV.

PLUTELLINÆ.

DIPLOCARDINÆ.

BENHAMINÆ.

PERICHÆTINÆ.

LIMNODRILIDÆ.

INTRODUCTION.

THESE researches are based upon collections made in various parts of North America during the last few years. The paper completes the account of all species of the Terricolide families mentioned, on hand at the time of going to press. There remain to be worked up some new species of *Diplocardia* from Nebraska, received from Professor H. B. Ward, and some very interesting species of *Benhamia* and *Ocnerodrilus*, collected by Mr. Robert E. Snodgrass on the Galapagos Islands and on Clipperton Island. These specimens were received too late to be described in the present paper.

An account of the family of Enchytraeidæ, of which there are at least over fifty new species on the Pacific Coast, is now under way and it is expected will be finished during the coming year.

The author is under great obligation to those who have contributed to his work by presenting specimens. Among those who have thus aided in making known our interesting and important fauna of Oligochæta are: Professor Albert Koebele of Honolulu, Hawaii; Professor C. H. Gilbert and Mr. R. C. McGregor of Stanford University; Dr. H. W. Harkness and Mr. Alexander Craw of San Francisco; Professor C. H. Tyler-Townsend of Las Cruces, New Mexico; Professor Frank Smith of Champaign, Illinois, and Messrs. Brimley Brothers of Raleigh, North Carolina.

GEOSCOLECIDÆ.

Pontoscolex *Schmarda.*

Pontoscolex corethrurus *(Fr. Müller)* mexicanus, subsp. nov.

PLATE V, FIGS. 1–16; PLATE VI, FIGS. 17–23; PLATE VII, FIGS. 24–26, 35–37.

Definition.—Length 95–110 mm. (those from Baja California 200 mm.); diameter 3–4 mm.; somites 145–212. Setæ bifid, slightly ornamented; setæ *c* and *d* wider apart in II than they are in III and IV; setæ *c* in II in line with *d* in III; setæ *d* in II more dorsal than setæ *d* in III and IV. Penial setæ with eight or nine pockets at apex. Prostomium present, but retractile; mouth at apex and terminal. Caudal zone 28–76 somites from tail-end, and 107–118 somites from the head. Clitellum in XV–1/4 XXIII. Tubercula pubertatis in XIX–XXII. Gizzard in VI. Sacculated intestine commences in XVII. Calciferous diverticles in VII, VIII, and IX. Spermathecal pores in the posterior part of VI, VII, VIII, but the main body of the spermathecæ respectively in VII, VIII, IX. The spermathecal duct about five times longer than the pouch. Nephropores in line with setæ *c* and *d* in all somites except III, where they are absent, and in II, where they are slightly more ventral than in *c*. Hearts in XI and XII. One pair of testes in XII. One pair of sperm-funnels in XII. Ovaries in XIII; oviducts in XIV. One pair very long, dorsal sperm-sacs extending to the posterior part of the clitellum. Spermiducal pores in the anterior part of XXI. Septal formula:—

$$\overline{\overline{\text{III/IV}}},\ 0,\ 0,\ \overline{\overline{\text{VI/VII}}},\ \overline{\overline{\text{VII/VIII}}},\ \overline{\overline{\text{VIII/IX}}},\ 0,\ \overline{\text{X/XI}}.$$

No additional capillaries in the caudal zone.

Habitat.—Mexico and Central America.

This worm was found to be very common in the coast territory from the Cape Region in Baja California through Mexico, Guatemala, and Salvador in Central America. Specimens are represented from the following localities in Baja California: Todos Santos, Miraflores, San José del Cabo and all parts of the Cape Region. (Eisen 21.) Todos Santos is the most northern point where the species was found, and it is doubtful if it extends further north. It has not been found in California, U. S. A. In Mexico I have collected specimens in abundance at Mazatlan, San Blas, and Tepic. As the latter place is over 4,000 feet above the sea, it will be seen that the species possesses a great vertical range. I do not think, however, that it occurs in localities subject to frosts. In Guatemala, Salvador and Honduras, the species extends from the Atlantic to the Pacific. The Cape Region specimens are all from the lowlands. They are larger than those from the mainland of Mexico and from Central America, but I have found no other distinguishing feature.

The anatomical and histological description given below is based on specimens from Tepic, taken in the vicinity of the city. The Central American specimens were not sufficiently well preserved to warrant sectioning, and the Cape Region specimens appeared to me to be so similar, except in size, that no effort was made to study their finer anatomy.

Characteristics.—The following points in the structure of *Pontoscolex corethrurus* subsp. *mexicanus* are either especially characteristic of this form or they have not before been mentioned as belonging to *Pontoscolex corethrurus* by those who have previously studied the species.

1. The septum III/IV is very wide and greatly thickened.

2. Tubercula pubertatis are present in somites XIX–XXII. The glandular cells characteristic of these organs penetrate into the muscular layers of the body-wall.

3. The spermathecæ open into the posterior parts of somites VI, VII, VIII, but the main pouches are in somites VII, VIII, IX. The spermathecal pores are thus preseptal.

4. Setæ *c* and *d* in somite II are not in line with setæ *c* and *d* in somites III, IV and following; but setæ *c* in somite II are in line with setæ *d* in III and IV, and setæ *d* in II are more dorsal than setæ *d* in the other somites.

5. Setæ *c* and *d* in somite II are somewhat larger than any other of the anterior setæ.

6. The spermathecæ are much longer than those figured by Perrier. The duct is about four and a half to five times the length of the pouch and about one-third its width.

7. There are no extra blood capillaries in the caudal zone, such as those described by Horst in his account of *Pontoscolex corethrurus*.

8. The male pore is on the anterior part of somite XXI and not in the intersegmental groove. Whether this is a constant feature I am unable to say. The pores are not visible from the exterior.

9. There is a large prostomium which is generally found retracted in preserved specimens.

10. The caudal zone is characterized by a large number of what seem to be sense-cells without terminal sense-hairs.

11. In the anterior part of the anterior somites the longitudinal muscular layer is separated from the transverse muscular layer by vacuoles traversed only by isolated strands of mixed muscular tissue.

Affinity.—After a consideration of the foregoing peculiarities in structure, the question naturally arises whether the form of *Pontoscolex* from Tepic and Baja California is a variety, a subspecies, a distinct species, or, perchance, identical with the *Pontoscolex corethrurus* described by a number of investigators. With our present knowledge of the anatomy of the type-specimens of *P. corethrurus* and of those specimens from other localities which have been referred to this species, this question cannot be satisfactorily answered without a re-examination of all the types. The descriptions given by the various investigators either differ considerably from each other in essential points, or they are insufficient to enable one to satisfactorily determine a specimen. Dr. Rosa (1) has, as is well known, endeavored to

harmonize all the conflicting statements and descriptions, and has expressed the opinion that all refer to one single species, which must then be known as *Pontoscolex corethrurus* (Fr. Müller). Horst and Beddard, who are the only other investigators of this species, readily coincided with the views expressed by Rosa; and Beddard, in his large monograph on the Oligochæta, has joined the variously described species, *Urochæta hystrix*, *U. dubia* and *Pontoscolex corethrurus*, under the one head, *P. corethrurus*. I do not concur with them in this arrangement, as my specimens differ from those described by Beddard in at least one very important point, namely, the location of the spermathecal pores. Beddard distinctly states (45) that "the aperture is in each case placed quite close to the anterior margin of the segment." In another place he states that the spermathacæ are in segments VII, VIII and IX. It can only be understood from this that the pores are situated in the anterior parts of VII, VIII and IX, and near to the anterior margin of the respective segments. In my specimens from Mexico, the pores of the spermathecæ are preseptal, that is, they are situated in the posterior part of the somites, which character I think is of sufficient importance to be of specific value. If, after re-examination, the postseptal position of the spermathecæ in the species examined by Beddard, Rosa, and Horst proves to be constant, then there will remain no doubt as to the specific difference of my Mexican specimens.

A re-examination of the various specimens described as *Pontoscolex corethrurus* is, therefore, highly desirable, and until this is made the question of the distribution of *Pontoscolex* cannot be finally settled. There is every reason to believe that several additional species of *Pontoscolex* will soon be found. In his monograph on the Oligochæta, Beddard recognizes the following species: *P. corethrurus* (Fr. Müller), *P. arenicola* Schmarda and *P. hawaiiensis* Beddard. To this number has recently been added another, *P. Lilljeborgii* (Eisen 19). The fact that we possess four distinct species of *Pontoscolex* argues very strongly

against the supposition that *Urochæta hystrix*, *U. dubia* and *Pontoscolex corethrurus* are one and the same species.

Following will be given a detailed description of *Pontoscolex corethrurus* subsp. *mexicanus*.

EXTERNAL CHARACTERS.

Size.—(figs. 1–6.) The average length of the Tepic specimens is much less than that of the specimens from the Cape Region. The largest of them average 111 mm., the smallest 95 mm.; the width in front of the clitellum at the narrowest part is about 3 mm. Specimens from the Cape Region measure 200 mm. in length, with a diameter of 4 mm. The number of somites in the Tepic specimens ranges between 145 and 212. Figure 1 represents a specimen natural size, narcotized and preserved in alcohol. The specimen is not, however, as extended as when crawling about during life.

Setæ.—The anterior setæ are strictly paired and the dorsal setæ are likewise paired till they reach somite XII, where they begin to separate a little, continuing about equidistantly in XII, XIII and XIV, and running only slightly deltoid. In XV they separate more, and in XVIII they are at the greatest distance apart, continuing to remain the same to about somite XLII. In or near this latter somite setæ *c* continue in a straight line to the caudal zone, or for about 44 somites from the tail-end. From the caudal zone to the tail-end the arrangement of the setæ is quincuncial, in the same manner as has so often been described and figured by various investigators. The difference in the size and location of the setæ in somite II (figs. 3 and 4) has already been mentioned.

There is a difference between the penial setæ of my specimens (fig. 7) and those figured by Perrier. His figure represents a penial seta with sixteen cup-shaped depressions, while the setæ of my specimens have only eight or nine.

Anterior Somites.—(figs. 2, 3, 4.) Although Horst (17) has shown that there exists a real prostomium extending

beyond somite I, Beddard (86) has nevertheless found it necessary to question the presence of this lobe. Thus we find in his definition of the species, "prostomium absent." My sections show conclusively that Horst is correct in his statement, and that a prostomium is really present, though it is of small size (supposing, of course, that my Mexican specimens do not differ in character from those of Horst, or that Beddard and Horst really examined the same species, of which I am not convinced).

The prostomium is frequently retracted, and in specimens which have been directly immersed in alcohol it is probably always retracted to such an extent that it cannot be seen from the exterior. In figs. 2 and 3 the prostomium is shown as seen from the lateral and ventral sides; in fig. 4 it is seen retracted. This peculiarity probably accounts for the statements of various authors as to its presence or absence.

The inner, anterior lips (fig. 9) of the prostomium are distinct and swollen, showing a bilobed apex. The entrance to the alimentary canal begins between the two lobes.

Somite I is much wider dorsally than ventrally, as shown in fig. 9. The surface of the posterior part of somite I is sulcate in the direction of the long diameter of the body, and the whole of somite II is similarly sulcate and rugose (figs. 2–4). Somite II is much wider than somite III and slightly wider than the dorsal part of somite I. Somite II is the most anterior somite having setæ. The anterior somites increase in width towards IX, and somites VI–IX are generally much shorter and more prominently ringed than the others. Somites X to XIV are of almost the same size, and the middle ring of each of these somites projects much less than do those in the anterior somites.

Clitellum.—(fig. 5.) The clitellum begins with somite XV and extends through one-fourth of XXII. It is well defined, especially with the beginning of the anterior part of somite XV. Anterior to this, the body is narrower than in somite XV and those following.

Exteriorly viewed, the clitellum is saddle-shaped, but there is a continuous row of clitellar cells even on the

ventral side of the body. This ventral zone is quite narrow, gradually increasing in width towards the tubercula pubertatis (fig. 5).

Caudal Zone.—(fig. 1.) The location of the caudal zone varies considerably in different individuals, as may be seen from the following table of specimens taken at random from the collection from Tepic. The numerals indicate the number of somites from head to zone and from end of zone to end of tail, etc.

	From head to caudal zone.	Caudal zone.	From end of caudal zone to end of tail.	Total.
No. 1.	111	6	74	191
No. 2.	108	5	76	189
No. 3.	118	6	71	195
No. 4.	111	5	54	170
No. 5.	107	5	48	160
No. 6.	113	5	44	162
No. 7.	107	4	wanting	117
No. 8.	118	8	74	212
No. 9.	110	7	28	145

As will be seen from the above table, the caudal zone generally consists of from five to seven somites, the number differing according to its location. The distance from the clitellum is more constant than the distance from the tail-end. The former varies from 107 to 118 somites, the latter varies from 28 (or none) to 74 somites. The two specimens with the very short tail may have had a portion broken off; still the variation is such as to clearly show that the distance to the tail-end is the least constant one. The structure of the caudal zone will be referred to later.

Tubercula Pubertatis.—(figs. 19, 20.) The continuous elevated ridges constituting the tubercula pubertatis have already been referred to as occupying somites ½ XIX–½ XXIII. They begin in the center of XIX and end in the center of somite XXIII. Cross-sections show that this ridge is a true tubercula pubertatis organ, being composed of the same kind of glandular cells as are found in other genera, such as *Sparganophilus* and *Benhamia*, and which have also been figured by Beddard, Benham and others. There is

a great similarity between the structure of these tubercles in the present species and those found in *Sparganophilus*. The glandular cells (fig. 20) are long and narrow, pear-shaped, or oblong and club-like, with round nuclei near the wide distal apex. Between them are also found other glandular clitellar cells, as well as a few hair-tipped sense-cells. The most interesting feature of these true tubercula pubertatis cells is that they extend through the two muscular layers of the body-wall to the cœlomic epithelium, but do not penetrate into the cœlomic cavity (fig. 19). Similar cells are found in *Diplocardia Koebelei*.

Beddard has shown that there are, as regards structure, two kinds of tubercula pubertatis. In one of these the glandular cells extend into the cœlom, as in *Perichæta*, while the other kind is associated with glands which do not extend into the cœlomic cavity, but which are confined to the epidermis. Beddard's suggestion that this morphological distinction may not prove to be of very great importance is undoubtedly correct. In *Pontoscolex* we find that these glands are intermediate between the two extreme types. In a very few instances I have observed one or two of them penetrating the cœlomic epithelium, which makes the transition all the more complete, and proves what has already been suggested (Eisen 18), that in the terrestrial Oligochæta the tubercula pubertatis are always of the same morphological nature, whether their exterior forms take the shape of ridges or papillæ; also that the differences consist principally in the size of the glands and in the number of sense-cells between them. In *Pontoscolex* these sense-cells are few and small; they are never found on the ridge of the papillæ, but are confined to a narrow groove on either side, very much as in *Sparganophilus*. The tips of the sense-cells project through the cuticle; they are knob-like, appearing very much like minute pin-heads, and are about as long as the cuticle is deep (fig. 20).

The tubercula pubertatis glands do not immediately join the clitellar glands. There is a narrow zone of narrow glandular cells which separates the tubercula pubertatis ridge from the regular clitellar cells (fig. 20).

INTERNAL CHARACTERS.

Body-wall.—(figs. 11, 17, 20.) In a longitudinal section of the body-wall we may readily observe how in the anterior somites the muscular layers are arranged in a characteristic manner. The general rule in Oligochæta is for the two muscular layers to be rather closely superposed, continuing in the same intimate relation throughout their length. In all the anterior somites of *Pontoscolex* the distance between these two muscular layers varies, even in various parts of the same somite. Thus, in the posterior part of one of these somites, beginning at the center, the two muscular layers are, as usual, placed one on the other, with no prominent space between. In the anterior part of the same somite the two layers are not so placed, there being large open spaces between them, separated only by narrow muscular strands (figs. 9, 17). The most anterior somites are most differentiated in this respect, the posterior ones the least so, and between these two extremes there is a series of intermediate grades. Thus, in somites II to VI there are six small openings; in VII to IX, five openings; in X, four openings; in XI, three; in XII, two; and in XIII there is but one. It is not claimed that these numbers are always constant, but they were the same in the three specimens which I sectioned up longitudinally. In the posterior somites, beginning with XIV, the two muscular layers are as intimately superposed as in most other worms.

We may also note another peculiarity of the epidermis, namely, the absence of unicellular glands in the anterior part of the somites lying furthest anteriorly. Even in the other somites it is found that the posterior part contains more unicellular glands or goblet cells than the anterior part (figs. 11, 17). These glands are of two kind, judging from their staining qualities. In almost every longitudinal section there will be found one or two unicellular glands which stain reddish with such stains as toluidine or thionin; while all the other glands take a bluish stain. The position of the reddish staining glands appears to be quite constant in the posterior part of the somite.

Auditory Cells.—(figs. 98–111.) In a previous paper (Eisen 19) the auditory cells have already been described in detail. After these investigations were completed, however, a few very young specimens of *Pontoscolex* from Tahiti were received through the courtesy of Mr. Alexander Craw. As the worms were alive when brought to me, opportunity was afforded for careful fixing, and the study of these specimens has enabled me to settle some points which were left in doubt in the former paper. Especial reference is made to the very minute structures found in every auditory cell, which the author described as nerve-endings or nerve-plates. This decision does not now appear to be correct, however. The new methods of fixing have made it possible to more clearly demonstrate their minute structure.

In a former paper on the blood of *Batrachoseps* (Eisen 21) the name archosome was suggested for the structure composed of centrosome and spheres, and in the following descriptions this term will be used to designate the structures which were at first supposed to be nerve-plates. They are not situated on or at the surface of the cell, but in its interior, about half way between the nucleus and the cell-wall. The archosomes are of varying size: some are very small (possibly due to a state of shrinkage) and show no interior structure; others are comparatively large and are distinctly differentiated. The largest archosomes appear as a flat disc, as large or larger than the nucleus of the cell. Between these two extremes there is a series of intermediate sizes and forms. But, small or large, the archosomes always appear to be surrounded by a defining membrane which is very sharply defined in the largest of them. The archosomes, even in the small cells, are frequently unequal both in size and form (figs. 100, 101); more rarely they are of the same size (figs. 99, 109, 102, 106).

In each archosome there are nearly always two definable zones, one interior to the other. The outer of these zones, which is much the larger, I identify as the archoplasm or centrosphere (Eisen 20). In this sphere there

may be seen one or more dark-staining dots, the centrosomes, surrounded by a more or less diffused zone or sphere,—the somosphere (Eisen 20). The latter is either star-like, as in fig. 106, or well defined and spherical, as in figs. 105 and 106. In some archosomes I have found two separate somospheres, each with one or more centrosomes. In fig. 107 one of the somospheres in *a* is much larger than the other and contains two centrosomes connected by a dark band. In the specimens from Tahiti, I have never found a cell in which more than two archosomes could be identified with certainty. Their position in the cell is very constant, always below the nucleus, close to the central cylinder of cytoplasm, which projects from the nucleus downwards. In a specimen from Mexico, four or more archosomes (Eisen 19) were found in some of the cells.

The radiations which are frequently seen projecting from the archosome and which are, sometimes, as clearly defined as fibers are probably of strictly cytoplasmic nature and possess, perhaps, the function of supporting the archosome. As regards the other structures of these cells, I can add but little to the previous descriptions. The cytoplasmic agglomeration designated as otosome is easily fixed with corrosive sublimate or alcohol, but not so well with other fixatives. It cannot be demonstrated in every cell. The very fine plates supporting the cytoplasmic cap above the nucleus (fig. 98) are rarely satisfactorily stained except by the Benda iron-hæmatoxylin method.

Finally, mention must be made of a most peculiar form (fig. 100) of archosome which the author has observed only a few times. Its shape is that of a long sausage-like body of reticulated structure throughout, in which are seen several dark-staining granules, especially at the poles. Its location is always the same as that of the other archosomes, among which it appears to be an unusual or abnormal form. As regards earlier observations of the otosme, I find that Dr. Horst (17) distinctly but faintly outlines this body (fig. 37, Tab. IV,) but makes it appear as though connected with a tube running between the cell and the cuticle. He does not refer to it in the text.

Caudal Zone.—(figs. 1, 21, 22.) The location of this zone has already been described. It has been generally known as the "zone of growth," almost ever since it was so called by Schmarda. The zone of growth was first referred to as such by Fritz Müller, and since his time every investigator who has had an opportunity to study this interesting genus has speculated upon the significance and purport of this unusual structure. Fritz Müller and Beddard are of the opinion that the zone of growth is a place where new segments originate and where they may be most readily renewed. Beddard assumes that this swollen zone will easily break, and that at this point rapid segmentation is possible.

Horst (17) does not share Beddard's opinion. He points out that the zone is characterized by a large number of capillaries and figures these vessels (Tab. IV, fig. 40), but suggests no special use for them in this region. Upon what feature of the zone Beddard founds his theory of regeneration is not quite evident. Out of many hundreds of specimens of *Pontoscolex* collected by the writer, only one was found in which the caudal zone forms the terminus of the body, and here it is evident that the tail-end has been lost. I do not find, however, that *Pontoscolex* is more easily torn than other worms, and cannot see how the above theory explains the formation of this extraordinary structure, as far as known, only once paralleled elsewhere. I have sectioned a number of these zones of growth but have yet to find a single cell in mitosis, though the specimens were young and undoubtedly growing. This certainly seems to indicate that if the caudal zone is a place for active growth, the activity is apparent only under certain conditions, as when the tail is being regenerated, as suggested by Beddard. But if regeneration of the tail of *Pontoscolex* is an occurrence so common that a special organ is required for the work, we should expect to find a large number of worms with broken tails, which is not the case.

In regard to this zone, I can only say that the specimens examined by Dr. Horst differ materially from those I have

studied. While Dr. Horst has found an increased number of blood capillaries in the zone, I, on the contrary, find the zone to be remarkably free from blood-vessels in the epidermal layers. The long row of capillaries seen in Horst's figure does not appear in my preparations, and there is certainly nothing easier to demonstrate in an Oligochæta than blood-vessels, large or small.

The caudal zone is characterized by the very narrow segments of which it is composed. Any other portion of the worm of an equal length contains only about half as many segments as the zone itself. This further implies that the zone contains about twice as many septa and twice as many nerve-glanglia as any other portion of the body, and is therefore stronger and more sensitive than any other portion.

The structure of the epidermis of the zone is quite interesting. Horst and Beddard have commented upon the absence of glandular goblet cells in the epidermis of the zone, and Beddard has used this as an argument in favor of his theory of regeneration and growth. Horst (17) has pointed out that the absence of goblet cells and the presence of columnar epithelial cells makes a structure different from that which we would expect to find in a zone of growth,—such a one as is found in *Nais*, *Chætogaster*, *Lumbriculus*, etc.,—and that there is, in fact, no trace of any embryonic or primitive features in the zone. If to this is added the fact that the zone is most regular in the size and number of its somites, it appears as though very little remains to indicate that it is a zone of growth and regeneration.

If the histological structure of the epithelium of a segment of the zone is considered, it is found to consist of two distinct structures: one of these borders the intersegmental groove and is composed of uniform, large and regular supporting cells with large ovoid nuclei; the other occupies the larger portion of the epidermis and lines the outer convex part of the somite; it contains comparatively few supporting cells, but has a large number of cells of a different nature. In fig. 21 I have endeavored to illustrate this;

i. gr. represents the part of the epithelium facing the intersegmental groove, while *ex* indicates the convex part. The great majority of the cells are long and narrow, tapering from the cuticle.

Figure 22 represents a single cell. Of these cells there are two different forms: one has a short nucleus in which is always seen a large central nucleolus; the nucleus of the other is longer and narrower, generally without any nucleolus. The cytoplasm of the two cells differs; it is agglomerated behind the nucleus in one, but is not so placed in the other. This cytoplasmic clot stains a brilliant red with thionin, just as do the nuclear chromosomes of the several cells. The structure of these cells points to a difference in function also, and undoubtedly they serve a purpose other than that of supporting cells. I believe them to be some kind of sense-cells. The free distal ends are drawn out finely and are frequently seen penetrating the basal membrane separating the epithelium from the muscular layers, finally losing themselves among the muscles and connective tissues. The cells cannot be organs of smell or taste, because they do not end in sense-hairs; but they are eminently adapted to function as organs of touch, and are probably especially sensitive to vibrations. Their free ends offer an unusually large surface to the exterior. The distal ends, which are very thin, project beyond the regular line of the epidermis and connect with nerve-fibres. Similar cells are found among the goblet and supporting cells of the epidermis of the general body-wall, but they are present there in small numbers. I also find such cells to be numerous in the cephalic lobe of many species, a proper location, the prostomium being principally an organ of touch. The decreased number of supporting cells, the narrowness of the somites, enabling twice the number of nerve-centers to be present in the same space, and the great number of "touch cells" would, therefore, it seems to me, make the caudal zone especially sensitive to vibration or to touch, and increase its efficiency as an organ of touch.

But what would be the advantage of such a zone? Undoubtedly a greater sensitiveness at the point of the tail of the worm where it projects out of the mud or soil. *Pontoscolex* is mainly a mud worm, one species, *Pontoscolex Lilljborgii*, being Limicolide in its habits. The species under discussion was found to be common in wet places,—along river banks, etc., where the mud was barely covered by water. The least movement of the ground causes the worms to retire rapidly down the burrows. Like all other aquatic Oligochæta, the favorite position of *Pontoscolex* is with the tip of the tail extending above the mud, making the caudal zone its point of contact with the surface of the soil. It is evident that were this point especially sensitive it would be of great advantage to the worm, enabling it to quickly detect vibrations caused by the approach of birds or other enemies, and giving it time to retreat into the burrow.

But I believe the caudal zone to possess also another function of no small importance. It is especially rich in muscular fibres (fig. 21), much more so than the somites adjoining the zone. Upon several occasions I have observed the caudal zone to bulge out and increase in width when the live worm was touched. This swelling up of a portion of its body would undoubtedly help the worm to retain its hold in the ground, and prevent its being easily pulled out.

Protective Structures.—Other devices which enable this worm to retain its hold in the ground are the peculiar vacuoles in the anterior somites and the corkscrew twist of the body. The former enables the worm to suddenly extend the muscular layers and to hug the soil closer. The corkscrew twist must serve the same purpose.

The extensive distribution of *Pontoscolex* would indicate that it must be unusually well protected. To the protective organs just described we must also add the intratyphlosolar canals which enable the typhlosole to discharge into the intestine; these canals will be described later. To recapitulate, the organs and structures which are especially favorable to the survival and consequent distribution of *Pontoscolex* are as follows:—

1. The anterior vacuoles in the muscular layers of the body-wall, which enable the body to suddenly expand and to cling to the burrow.

2. The caudal zone which partly serves the same purpose and which also enables the worm to quickly perceive the approach of enemies.

3. The corkscrew-like twist of the posterior portion of the body, which enables the worm to more readily cling to the soil.

4. The auditory cells in the epidermis.

5. The intra-typhlosolar canals, which enable the typhlosole to evacuate itself into the intestine.

6. The quincuncial arrangement of the posterior setæ, enabling the worm to cling to the burrow with greater tenacity.

Septa.—(fig. 9.) There are especially thickened septa. The one furthest anterior is found between somites III and IV, and therefore bounds the posterior surface of the very large suprapharyngeal gland. This septum is as thick as any of the posterior ones. No such septum is figured by Horst (17, fig. 33), and this further strengthens me in the belief that the specimens he studied belong to a different species from mine. The septa which should be separating IV/V and V/VI are absent, but the following septa are greatly thickened. There is no septum between IX and X, a character which is possibly of generic importance.

Spermathecæ.—(figs. 8, 11.) The spermathecæ of *Pontoscolex corethrurus* have more than once been wrongly located, and nowhere do I find it explicitly stated where and how they are situated. The most important character of spermathecæ generally is the position of the pores. The pores may be either preseptal or postseptal, and the main body of the spermathecæ is situated either in the same somite as the pores, or in a somite anterior or posterior to the somite containing the pores. Beddard's statement that the spermathecæ are found in somites VI, VII and VIII has already been referred to in this paper. Horst (17) in his latest

paper does not refer to the spermathecal pores, and in an earlier paper (7) he states that these pores are on the front margins of VI, VII and VIII, in front of the nephropores. If this is constant, then the species described by Perrier, Rosa, Horst and Beddard cannot be identical with my species, in which the spermathecal pores are situated in the posterior part of VI, VII and VIII, while the spermathecæ themselves are in VII, VIII and IX.

Suprapharyngeal Glands.—(fig. 9.) This very large mass of glands which discharges into the pharynx extends backwards to the posterior part of somite III, where it is bounded by the very thick septum separating III and IV. From this septum there radiate forward a number of muscular strands which separate the lobes of the above glands, and which are, furthermore, attached posteriorly to the muscular walls of the pharynx. The glands are distinctly unicellular, each with its own duct, which in many instances can readily be followed to the pharynx. The discharge pockets (fig. 10) are globular, with very narrow ducts. The pharyngeal glands are developed only dorsally. There are no other septal glands.

Calciferous Diverticles.—(figs. 23, 24, 25.) The three pairs of calciferous diverticles open separately into the intestine from the posterior part of their respective somites. Each diverticle opens independently of the others and on the dorsal part of the intestine. The histology of the diverticle has already been described in a general way by Perrier (5), more particularly the vascular part connected with these organs. I can add only a few details.

The three pairs of calciferous diverticles are similar in their structure and secretions, the latter being composed of spherical lime-globules without any characteristic structure. The secreting cells are narrow and only one layer thick, with round or oblong nuclei slightly narrower than the cell is wide. The lime-globules vary considerably in size, the largest being of the same diameter as the larger nuclei of the secreting cells. No crystals were found.

A cross-section of a calciferous diverticle shows it to be composed of layers and hexagonal chambers rather regularly arranged in rows. Between each chamber there is a tiny blood-sinus. This blood-sinus surrounds the glands on all sides, but it is larger at certain points. On the exterior of the diverticle we find blood-vessels with distinct walls. On the dorsal side of the diverticle the blood-vessels are covered by chloragogen cells which are characterized by the manner of their attachment. Instead of being affixed by a single spur, they adhere to the vessels by means of several narrow projections (fig. 24). Each diverticle enters the intestine by a separate ciliated duct, the ciliation continuing some little distance into the diverticle (fig. 25, *X*). The blood-vessel supplying the diverticle is directly connected with the large median, dorsal vessel, a section through this part showing the two vessels to be continuous and even and without valves.

There is a continuous blood-sinus in the sacculated intestine in the clitellar somites, which varies greatly in thickness. The blood is never found crystalized, as, for instance, in *Sparganophilus*.

In somites XVI and XVII the muscular layer of the intestine is considerably increased in thickness, and is about three times as wide as usual. The sacculated intestine commences in XVIII. The intestinal epithelium in somites XVI and XVII is strongly ciliated.

Typhlosole.—(figs. 36 and 37.) This organ is large, being sometimes twice as long as the diameter of the intestine. It is twisted and folded, but always dorsal. The blood-sinus occupying the center of the typhlosole is at certain intervals enlarged, forming globular or oval chambers. The epithelium of the typhlosole consists of rather short cells of the same nature as the cells of the intestine proper. The central blood-sinus in the typhlosole is confined by a distinct and nucleated membrane (fig. 36 *b*). The typhlosole consists of an enormously enlarged epithelial fold with a central blood-vessel, and is thus not a mere fold of the whole intestine, as for instance in *Allolobophora*,

where the center of the typhlosole is occupied by two rows of chloragogen cells. In our species of *Pontoscolex* the blood-vessel occupies the central part of the typhlosole, there being no trace of chloragogen cells.

The blood-supply of the typhlosole is derived from the dorsal vessel in two different ways, alternating with each other in each somite. One of these methods of supplying the blood is by a median, perpendicular vessel which dips down from the dorsal median vessel into the typhlosole. This vessel is very short. Besides this perpendicular vessel, there are paired lateral vessels which start out sideways from the dorsal vessel and alternate with the perpendicular vessel (fig. 35). They connect more laterally with the blood-sinus of the typhlosole (fig. 36 *a*).

Intra-typhlosolar Canals.—(fig. 36.) Throughout the length of the typhlosole there exist in the upper part of this organ a great number of internal ciliated canals enclosed by a muscular investment continuous with the circular muscular layer of the intestine. These canals, which are short, occupy the part of the typhlosole situated between the lateral and median vessels which supply the typhlosole with blood, as previously described. In transverse sections passing directly through, or in the immediate vicinity of, these vessels, no intratyphlosolar canals are cut through; but as we approach midway between these lateral and perpendicular vessels cross-sections of these canals come into view. Generally there is but one canal, but there may be two or even three parallel canals, of which one is larger than the others. These intratyphlosolar canals originate in the interior of the typhlosole, follow this organ in a parallel line for some little distance, and then bend sufficiently to open out into the upper part of the intestine at its junction with the typhlosole (figs. 37, *a*, *b*, *c*). There is no connection between the canal and the cœlomic cavity.

These canals are all of the same uniform structure,—a single row of cells with very large nuclei. The cells are ciliated along the lumen of the canal and resemble those of the sperm-duct. These canals probably serve as safety

valves, enabling the typhlosole to discharge superfluous blood into the intestine. The advantage of such canals is apparent in a typhlosole of such large dimensions as that of *Pontoscolex*.

Chloragogen Cells.—(figs. 24, 26, 37.) The chloragogen cells of the dorsal vessel are of a different structure from those of the intestine. They lack the granules possessed by the latter and they stain less intensely with aniline stains, such as eosin. The chloragogen cells of the intestine are much longer on the dorsal side, gradually diminishing laterally. The long dorsal cells are separated from each other by very narrow interstitial cells with narrow nuclei (fig. 37 *a*). Further down the sides of the intestine no such interstitial cells are found.

Corresponding to the long dorsal chloragogen cells we find similarly very long epithelial cells on the opposite and inner side of the intestine (fig. 36); they are, however, slightly shorter than the chloragogen cells. Laterally the epithelial cells narrow down in the same way as the chloragogen cells on the opposite side of the blood-sinus.

Vascular System.—The dorsal vessel is much enlarged, occupying about one-fifth of the body-cavity in somites XI to XVII, though even posterior to the latter segment it is of considerable size and of nearly the same thickness. The dorsal vessel is not strictly double, as for instance in *Pontoscolex hawaiiensis* Beddard, but it may be said to be rudimentary double. By this I mean that cross-sections show that in certain places, probably in the center of the somites, the vessel is divided through the center by an upright bar, which undoubtedly represents a diaphragm dividing the vessel longitudinally. After entering somite X the dorsal vessel narrows down. The supraintestinal vessel is enlarged in two or three somites, the enlargement beginning just in front of the sacculated intestine in XVII and extending forward as far as XII, at which point it becomes much narrower.

There are two pairs of hearts in XI and XII, both connected with the supraintestinal vessel. There is considerable difficulty connected with the counting of the septa, owing

to their thinness and intricate folding, but it is certain that the last heart is found in the same somite as the sperm-funnel.

Nephridia.—The nephridium is furnished with a cœcal pouch, and is of large size. It is differentiated into two large wings at the junction of which is situated a bulbous spinxter (figs. 12–16). The upper part of this spinxter is ciliated. It consists of a number of closely packed, lamellæ-like cells, with lamellated cytoplasm. The cœcum leads into a short narrow duct which opens into a bulbous, glandular chamber. The glandular pouch is present in all nepridia posterior to the clitellum. The spur is long and unusually narrow. The windings are much smaller than in most other nephridia. There is a narrow "bridge" without cilia. I have not had the time to study out the course of the canals, but it appears to be more complicated than in *Kerria*, *Argilophilus* and *Microscolex*, in each of which genera I have followed them in detail. There are numerous blood-vessels both in the pouch and the folds, as well as in the spur; and owing to them and to the numerous muscles attaching the nephridia to the body-wall, the study of the ducts is difficult. The nephrostome is of large size, larger than I have seen in any other nephridium. In form and structure it resembles the drawing given by Perrier, but the funnel is always situated in the somite next anterior to the nephropore. The nephridium is readily dissected out entire. The most anterior nephridium has the form delineated by Perrier. I can find none of the funnels described by Beddard as belonging to this nephridium. The peculiar gland forming an appendix to the central part of the nephridium consists of several rows of very large bottle-like cells (fig. 12*b*.) with a coarsely granulated secretion which is so dense as to hide the nucleus of the cell even in quite thin sections. This granular substance stains intensely blue with the methylen colors. The cells open into a wide, common lumen. The inner cells are surrounded by much smaller cells with distinct membranes, also containing a coarse granulation, which, however, stains but feebly.

Lymphocytes. — (figs. 110, 111.) The lymph of the cœlomic cavity contains numerous lymphocytes of various kinds, but principally amœbocytes. The lymph exuded from the irritated animals consists almost exclusively of amœbocytes and a few eosinophile cells.

The amœbocytes are of different sizes and forms, some being perfectly round and showing no pseudopodia, while others show numerous examples of such amœboid projections. Between these two extremes there are numerous intermediate gradations. One of the most extreme forms is figured at *G.*, fig. 110. The pseudopodia may be broad or pointed, many or few. The cytoplasm shows in places a branching or foaming structure (*D*) with concentrations of greater density in the longer arms. The archosome (Eisen 20) is more or less well defined and shows at least two concentrically arranged zones, one exterior to the other. The interior zone stains darker, and may, perhaps, be composed of centrosomes. The archosome is often surrounded by a denser granulated cytoplasm which is probably homologous with the granosphere. In double staining with eosin and methylen-blue, the archosome with the granosphere stains distinctly red, while the balance of the cell stains blue. The nucleus varies in shape and is either rounded and even, or polymorphous, as in leucocytes; but as there are intermediate forms, I conclude that all belong to the same class of lymphocytes.

Eosinophiles.—These are found in limited number; they are smaller than the amœbocytes, round, globular, without any amœboid projections, and their cytoplasm is composed of numerous intensely staining globules of erythrophile nature. The diameter of the eosinophile granules is about one-twentieth that of the cell itself. The nucleus of the eosinophile cell is much smaller than that of the amœbocyte.

Microcytes.—(fig. 117.) This name is proposed for very minute, non-nucleated bodies occurring in large numbers in the lymph, scattered among the lymphocytes. These bodies are oval in shape, pointed at both ends, and of different

sizes. The largest of them are never longer than the short diameter of the nucleus of the lymphocyte, but they are generally very much smaller. The majority of microcytes show a central dark-staining point, while others are apparently homogeneous, with only a shaded center. These microcytes are scattered everywhere in the lymph and even among the tissues, and now and then are found even in the cytoplasm of the amœbocytes. The smallest microcytes in some respects resemble bacteria, but the great variation in size precludes the possibility of their being such. It is possible that the microcytes are homologous with plasmocytes (Eisen 20). I believe they will be found to constitute regular elements of the lymph.

OCNERODRILINÆ.

GENERAL REMARKS.

There can be no doubt, as Michaelsen has pointed out, that Beddard's genus *Ilyogenia* is a true Ocnerodrilide, the only distinguishing character being the absence of prostates. The same character distinguishes the author's genus *Phœnicodrilus*, which, being later than Beddard's genus, must be withdrawn.

The prostates in *Ocnerodrilus* vary so much in size and development that it is difficult to determine when they are entirely absent. In *Phœnicodrilus tepicensis* a trace of the prostate remains as an atrial chamber near the male pore. In the closely related species *P. taste* there is no trace of this muscular part of the prostate. The former species thus stands intermediate between *Ocnerodrilus* and *Ilyogenia* or *Phœnicodrilus taste*. *Pygmæodrilus* has already been withdrawn by Michaelsen, but I prefer to retain both *Ilyogenia* and *Pygmæodrilus* as subgenera, to which I have added five others, each subgenus being defined by several characters.

Most of the African species belonging to group V seem to differ from all the other species in having the male pores approximated, a fact which is interesting to note in connection with Michaelsen's suggestion that the family of Eudrilinæ has descended from Ocnerodrilide ancestors.

A perusal of the key shows that these subgenera are not all of the same value. *Ocnerodrilus* (sens. str.) differs from all others in its peculiar sperm-sacs and in the absence of spermathecæ. *Enicmodrilus* and *Ilyogenia*, on the contrary, are more closely related. *Nematogenia* and *Haplodrilus* are quite distinct and had best be considered as distinct genera. *Nematogenia* is especially remarkable on account of its nematocytes or thread-cells, structures found in no other oligochæta.

Ocnerodrilus *Eisen.*

Definition.—Small terrestrial or aquatic worms. Setæ eight, paired. Clitellum includes the male pore in XVII. Pharyngeal and septal glands. A pair of intestinal diverticles in IX. With or without spermathecæ. One or two pairs of testes. Ovaries in XIII. With or without racemose sperm-sacs. With or without prostates, which, when present, open with the sperm-ducts, or, when more than one pair, in the somite immediately behind. Prostate contains only one layer of cells. No penial setæ. Two pairs of hearts. Lateral blood-vessels pass through the intestinal diverticles. Meganephridia paired, present also in the anterior somites, generally with cœlomic cell-mantle, sparsely traversed by blood-vessels.

KEY TO THE SUBGENERA AND SPECIES OF *Ocnerodrilus*.

Ocnerodrilus, *Leiodrilus*, *Pygmæodrilus*, *Ilyogenia*, *Enicmodrilus*, *Nematogenia* and *Haplodrilus*.

I. Prostates present. Two pairs of testes. No racemose sperm-sacs. Small, simple sperm-sacs capping the testes. No spermathecæ.

Ocnerodrilus EISEN, (sens. str.)

1. *occidentalis* EISEN.
2. *occidentalis* var. *sinensis* var. nov.
3. *occidentalis* var. *arizonæ* var. nov.

II. Prostates present. Two pairs of testes. Racemose sperm-sacs. No sperm-sacs capping the testes. Spermathecæ in IX, without diverticles.

Enicmodrilus, subgen. nov.

4. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ large and globular. Prostates of medium size. *agricola* EISEN.
5. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ long, cylindrical. Prostates thin, below medium size. Sperm-sacs in IX very diminutive..... *Rosæ* EISEN.

6. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ medium, narrow, cylindrical. Sperm-sacs in IX large, exteriorly hardly lobed. Prostates thick.
contractus EISEN.

7. Sperm-ducts not thicker at the pore. No setæ *ab* in XVII. One pair of very diminutive prostates. Spermathecæ small, pear-shaped, without distinct stalk. Sperm-sacs in IX and XII. Septal glands in V the largest, those in VII and VIII very small. Margins of setæ undulating.....*Hendriei* EISEN.

8. Sperm-ducts no thicker at the pores. No setæ *ab* in XVII. One pair of medium size prostates. Spermathecæ large, with short stalk. Racemose sperm-sacs in IX and XII. Septal glands in VI the longest. Margins of setæ undulating.
comondui, sp. nov.

9. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. One pair of diminutive prostates. Spermathecæ large, with distinct stalk. Racemose sperm-sacs in IX and XII. Septal glands in VII the longest. Margins of setæ smooth.
santi xavieri, sp. nov.

10. Sperm-ducts not thicker at the pore. No setæ *ab* in XVII. One pair of prostates in XVII, and one pair in XVIII. Margins of setæ undulating.....*limicola* EISEN.

11. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. One pair of large prostates in XVII. Setæ with even margin, but with a lunate cavity at apex. Spermathecæ medium sized, constricted transversely at centre. Racemose sperm-sacs in IX and XII.....*paraguayensis* ROSA (40).

12. Sperm-ducts not thicker at pores. No setæ *ab* in XVII. Setæ with even margin. One pair of small prostates. Racemose sperm-sacs in XII only. Septal glands in VI the largest.
mexicanus, sp. nov.

13. *mexicanus* var. *hawaiiensis* var. nov.

14. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. Setæ with even margin. One pair of large prostates open on a very large pair of papillæ. Racemose sperm-sacs in IX and XII. Septal glands in V the largest. Spermathecæ stalked, sac large, globular, and as wide as two ordinary somites.
tuberculatus, sp. nov.

15. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. Male papillæ large, surrounded by glandular protuberances projecting beyond XVII. Prostates large, extending to XXX. Spermathecæ stalked, the stalk with a slight local, lopsided bulging out of the lumen. Racemose sperm-sacs in IX and XII.....*Calwoodi* MICHAELSEN (27).

16. Sperm-ducts not thicker at the pores. Setæ *a* absent in XVII. Spermathecæ as well as prostates are very large.
Beddardi EISEN.

17. Sperm-ducts not thicker at the pores. Setæ *b* absent in XVII. Spermathecæ and prostates are very minute.
guatemalæ EISEN.

18. Sperm-ducts not thickened at the pores. Setæ *b* absent in XVII. Spermathecæ minute. Prostates large.....*sonoræ* EISEN.

III. No prostates. Spermathecæ in IX, without diverticles. Racemose sperm-sacs. No sperm-sacs capping the testes. Two pairs of testes.
Ilyogenia BEDDARD, (57).

19. No trace of the muscular part of the prostates remaining.
taste (EISEN, 17).

20. A trace of the muscular part of the prostates remains as a small atrial chamber at the male pore.....*tepicensis* (EISEN, 18).

21. No trace of the prostates remains. Ovaries fused in the median line.....*africana* (BEDDARD, 57).

IV. Prostates present. Two pairs of testes. Spermathecæ in VIII, without diverticles. Sperm-sacs present in X, XI, XII, not racemose.
Leiodrilus, subgen. nov.

22. *Eiseni* BEDDARD (20).

V. Prostates present. Spermathecæ in IX, with two or more diverticles. Racemose sperm-sacs. Male pores more or less approximated. Two pairs of testes.
Pygmæodrilus MICHAELSEN, (12).

23. Male pores close to the median line. Sperm-ducts thickened near the pores. Spermathecæ stalked, with 2 to 4 diverticles each.....*bucobensis* (MICHAELSEN 11, 16).

24. Male pores distant from median line. Sperm-ducts with a muscular, globular enlargement at the pore. Spermathecæ with a row of diverticles at the base.
quilimanensis (MICHAELSEN 12).

25. Male pores close to the median line. One single median spermatheca in IX, with four diverticles.
affinis (MICHAELSEN 11, 16).

26. Male pores not far from median line. One pair of spermathecæ in IX, with three diverticles.
bipunctatus MICHAELSEN (16).

VI. Prostates present. Spermathecæ in IX, without diverticles. Racemose sperm-sacs. No sperm-sacs capping the testes. Dorsal pores. One pair of testes. Rudimentary gizzards in VI and VII.
Nematogenia, subgen. nov.

27. *lacuum* BEDDARD (39).

28. *lacuum*, var. *panamaënsis* var. nov.

VII. Prostates present. Spermathecæ in IX, without diverticles. No racemose sperm-sacs. One pair of testes. No gizzard. No dorsal pores.
Haplodrilus, subgen. nov.

29. *Borelli* ROSA (40).

Subgenus **Ocnerodrilus** *Eisen.*

Structure of Sperm-sacs.—The structure of the sperm-sacs in *Ocnerodrilus* (sens. str.) is of considerable interest. In the author's description of the type-species of the genus no mention is made of the sperm-sacs, nor indeed were they discovered at that time, an oversight explained by the fact that in *O. occidentalis* the sperm-sacs do not project from the septa, but are mere small caps at the end of the testes. They are so small, even in fully adult specimens, that it is only in sections that they can be studied. The structure will be described under the species *O. occidentalis*, but I will here mention that it is identical with that of the sperm-sacs of the genus *Pachydrilus* which I have lately had occasion to investigate (fig. 132.)

Although always described as being void of sperm-sacs, *Pachydrilus* really possesses them. In this genus the sperm-sacs are also mere caps of the testes, the latter being multilobed, each lobe carrying its own sperm-sac. This character in *Ocnerodrilus occidentalis*—the lowest species in the genus—may be an ancestral character retained from its Pachydrilide ancestors. It is, however, hazardous to place too much importance on the structure of the sperm-sacs in a phylogenetic study of a genus, as even in closely related species they differ widely. Thus in *O. Eiseni* the sperm-sacs are not racemose, while in the majority of other species these sacs are racemose and traversed by trabeculæ. In this instance, however, I think that the small cap-shaped sperm-sacs of *O. occidentalis* and of *Pachydrilus* point to a close phylogenetic relationship. Another Enchytræide character is found in the diverticles of the intestine, a character also seen in Eudrilidæ, which family Michaelsen (21, p. 18) claims has descended from Ocnerodrilide ancestors.

Ocnerodrilus occidentalis *Eisen.*

PLATE XII, FIG. 123.

Definition.—Size 15 mm. Setæ *ab* are present in somite XVII and situated ventrally to the male pore. No spermathecæ. No racemose sperm-sacs, but small sperm-sacs capping the testes. Two pairs of testes in X and XI.

Sperm-ducts are not enlarged near the pore. Ovipores in front of and somewhat dorsal to setæ *b*. Septal glands of about equal size. Sacculated intestine in XII. Diverticles of the œsophagus are not divided into chambers. Prostates, one pair, very thick and large.

Habitat.—The type is from Fresno, California. In the collection there are also a number of specimens from Durango, Mexico, collected by Mr. James Ainsa in the parks of the city, in January, 1899.

It is interesting to note that the specimens from Durango resemble those from California rather than those from Arizona.

My former description of this interesting species was based on dissections and not upon sections, and, therefore, some characteristics escaped observation. Having since sectioned specimens from the original locality as well as from Durango, a more detailed description can now be given.

DETAILED DESCRIPTION.

Setæ.—The ventral setæ in the clitellum are a little farther apart than the corresponding setæ anterior and posterior to the clitellum, the distance *a–b* being a trifle greater than the distance *c–d*. This arrangement is more pronounced in the Durango specimens.

Sexual Zone.—The specimens from Durango which had been placed directly in alcohol have in the centre of XVII a markedly depressed sexual zone, which encloses the two male papillæ. This depression is much less pronounced in the specimens from Fresno. In the middle of the zone the two male papillæ stand out boldly. The papillæ are oblong-rounded, with a narrow wedge-shaped prolongation towards the median line. The main part of the papillæ is situated immediately dorsal to the ventral setæ *ab*, which are both present.

Septal Glands.—The septal glands, in V to VIII, are all of about the same size. The species differs in this from the var. *arizonæ*, in which the posterior glands, in VIII, are much smaller than those anterior. The dorsal part of the suprapharyngeal glands is continuous with the dorsal part of the septal glands in V.

Septal formula:—

$\overline{V/VI}$, $\overline{\overline{VI/VII}}$, $\overline{\overline{VII/VIII}}$, $\overline{\overline{VIII/IX}}$, $\overline{\overline{IX/X}}$, $\overline{\overline{X/XI}}$, $\overline{XI/XII}$.

Diverticles of the Intestine.—The diverticles are not divided by septa as in some of the other species, but possess interiorly only a few more or less projecting lobes. In this respect the species resembles the variety.

Testes and Sperm-sacs.—As has been previously stated, there are really two pairs of testes in X and XI, each testis being directly connected with a minute, narrow sperm-sac which does not extend beyond the somite of the testes. The sperm-sacs project straight upwards and the testes are very thin, in cross-section only one or two cells thick. The sperm-sacs are simple and sac-like, covered by peritoneum. They are nowhere connected with the septa, but appear to be simply extensions of the testes. There are no racemose sperm-sacs as in most of the other species. The sperm-funnels lie quite free behind the testes in X and XI and do not stand in direct communication with the sperm-sacs (figs. 123, 132).

Ocnerodrilus occidentalis *Eisen*, sinensis, var. nov.

Definition.—Length 25-30 mm., width 1 mm. Setæ *ab* in somite XVII are both absent. Sperm-ducts are separated though surrounded by a common muscular investment, their lumens remaining distinct till they reach the pore. The muscular investment is not thicker at or near the pore. The prostates are carried forwards (constant ?) as far as somite XIII, and show a slight bulbous enlargement at the pore. Clitellum, dorsally, XIII–XX; ventrally, XIV–XIX. Septal glands in V, VI and VII are of equal size; those in VIII are somewhat smaller. In other respects the variety resembles the species.

Habitat.—Several specimens collected by Mr. Alexander Craw from pots containing plants brought from China. The variations from the type which characterize this variety are slight, but as the specimens come from China it seems best to describe them as a distinct variety. The most characteristic features, such as the absence of spermathecæ and the peculiar sperm-sac caps which cover the testes, in connection with the absence of other sperm-sacs, show this

variety to be merely a form of *Ocnerodrilus occidentalis*. The septal glands in VII are larger than in the variety *arizonæ*.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Ocnerodrilus occidentalis *Eisen*, arizonæ, var. nov.

PLATE XII, FIGS. 124-134.

Definition.—Size 15-25 mm. Clitellum 1/3 XIII-1/2 XX. Setæ *ab* in somite XVII both present. No spermathecæ. Testes, two pairs in X and XI, directly capped by two small sac-like sperm-sacs in X and XI. No racemose sperm-sacs. Sperm-ducts not greatly enlarged near the male pore, but with a slight swelling of the lumen. Prostate and sperm-ducts joining in the same pore between the longitudinal layer and the epithelium. Prostates small, not extending beyond the clitellum. Septal glands of unequal size, the posterior ones much smaller. Diverticles of the œsophagus not divided into chambers. Sacculated intestine in XII.

Habitat.—Phœnix, Arizona, near irrigation ditches. Obtained through the kindness of Mr. Geo. A. Treadwell, October 19, 1896. A number of specimens have since been received from the same locality, collected by Master Grant, in January, 1897.

The variety differs but slightly from the species, but I believe the differences are worthy of being recorded, especially those concerning the size of the suprapharyngeal glands.

Ocnerodrilus occidentalis.	*Ocnerodrilus occidentalis*, var. nov. *arizonæ.*
SEPTAL GLANDS.	
Of about the same size. The most posterior pair of glands not smaller than those anterior to it.	Of different sizes. The posterior pair of glands is very much smaller than those anterior to it.
PROSTATES.	
Long, extending backward through several somites behind clitellum.	Short, confined to the clitellar somites.

Both species and variety differ from all other species of *Ocnerodrilus* in the absence of spermathecæ and racemose sperm-sacs.

EXTERNAL CHARACTERS.

Somites.—They increase slightly in size towards XI; XII and XIII are smaller, and XIII is smaller than XII; XIV is larger and from it the clitellar somites slightly increase in size towards XIX; XX is smaller.

The *prostomium* slightly divides somite I. It is furnished with a deep transverse groove in line with the upper margin of somite I.

The *clitellum* extends from the anterior 1/3 XIII–1/2 XX. It is equally developed on dorsal and ventral sides.

Male pores are situated on two small round papillæ in XVII, not connected by any special zone. In each papilla is seen a sac-like lumen, into which open the sperm-duct and the prostate, which thus unite but do not fuse just before reaching the exterior. Both setæ *a* and *b* are present at the male papilla, setæ *a* being situated on the side of the papilla.

INTERNAL CHARACTERS.

Genital Zone.—There are no tubercula pubertatis like those found in Lumbricidæ; but I find in the posterior part of somite XV and in the anterior part of XVII, as well as in XVIII, a zone in which the glandular cells of the clitellum are absent. Instead of these we find here a continuous row (in longitudinal sections) of very short and broad epithelial cells, characterized by having their frayed distal ends terminating in a number of long and pointed processes. Some of them project beyond the muscular layers and can even be followed to a point where I think they connect with the ventral ganglion.

The long tubular glands of the clitellum end at the beginning of the genital zone, though the long narrow ducts of many of these cells are seen to bend inwardly and pass through the zone. The zone possesses a stratum of longitudinally arranged glands running parallel to the body-wall, in somewhat the same manner as the spermathecal setæ-glands of *Diplocardia Udei*. None of these glands open

into a special chamber, as in the last mentioned species; but probably all open into the clitellar region outside of the zone.

There is an abundance of capillaries in the zone, and I have no doubt but that the zone is of sexual importance. Its structure reminds us in some respects of tubercula pubertatis, though there is an absence of true tubercula pubertatis glands. I could not find any regular sense-cells, though these occur in bunches in the epidermis of other somites.

Septal Glands.—There are four pairs of septal glands in somites V, VI, VII and VIII, the dorsal parts of which gradually diminish in size posteriorly. The dorsal part of each gland is much the largest, being broad and square in longitudinal section, while the ventral part is narrow and elongated. The glands in V, VI and VII are developed dorsally and ventrally, but the one in VIII is developed only on the ventral side of the intestine. These glands are only about one-fourth as large as the corresponding part of any of the anterior glands. The ventral parts of the anterior glands are of about equal size.

The *pharynx* is sac-like and in the form of a single dorsal pocket.

The *œsophagus* is narrow and straight and enters directly into the tubular intestine, which is also straight and only slightly widens between the septa. The diverticles of the intestine originate in the posterior part of IX. They are swollen and the part connecting with the intestine is very broad. The widest part of each diverticle is wider than the intestine in that somite. The folds in the walls of the diverticles are quite simple and resemble those of the intestine. Each diverticle has but one cavity, there being no separate chambers as in *Ocnerodrilus Beddardi* and in *O. taste*.

Septa.—Beginning with septum V/VI the ventral parts of the septa are a trifle thicker than the dorsal parts. The first considerably thickened septum is VII/VIII; X/XI is the thickest. None of the septa are thickened close to the body-wall or near the intestine.

Septal formula:—

$\overline{V/VI}$; $\overline{VI/VII}$; $\overline{VII/VIII}$; $\overline{\overline{VIII/IX}}$; $\overline{\overline{IX/X}}$; $\overline{\overline{X/XI}}$; $\overline{\overline{XI/XII}}$.

Testes.—The testes are slender and short, and connect directly with the minute, sac-like sperm-sacs, which are only slightly wider than the testes. Each testes has a central core of connective tissue, or muscular strands projecting from the septum, which I once mistook for a duct.

Sperm-ducts and Prostates.—The ducts join in the anterior part of the clitellum, but their lumens do not fuse until reaching the anterior third of XVII. After fusing, the ducts are slightly widened and increase gradually but very slightly in size until the body-wall is reached, where quite a little swelling is seen at the point of junction with the ducts. The sperm-duct joins the prostate before the two have fully penetrated the wall of the papilla. The prostates do not extend beyond the clitellum. The prostate cells are of two kinds: those most numerous are composed of glandular cells with very fine granulations taking the eosin stain; the others, which are fewer in number, consist of thin, rather irregular supporting cells, extending from the peritoneum to the lumen. The latter are probably the phylogenetic ancestors of the inner layer of cells which is characteristic of the prostate of the higher Terricolæ (fig. 133).

Ovisacs.—The oviducts are long and slender, opening in front of setæ *ab*. There are two small ovisacs in line between the oviductal funnels projecting into somite XIV.

Subgenus **Enicmodrilus**, subgen. nov.

The various species of the subgenus *Enicmodrilus* may be arranged as follows:—

I. Sperm-ducts with a thick muscular investment near the pores.
O. agricola EISEN.
O. Rosæ EISEN.
O. contractus EISEN.

I′ Sperm-ducts without thick muscular investment near the pores.
II. Setæ *ab* wanting in XVII.
a. Sperm-sacs only in XII. *O. mexicanus*, sp. nov.

a'. Sperm-sacs in IX and XII.		
b. Margins of setæ undulating. No tubercle at male pore.		
	One pair of prostates.	*O. Hendriei* EISEN.
		O. comondui, sp. nov.
	Two pairs of prostates.	*O. limicola* EISEN.
b'. Setæ with even margins, but with a lunate cavity at apex.		*O. paraguayensis* ROSA.
b''. Setæ with even margins. Male pores on large tubercles.		*O. tuberculatus*, sp. nov.
b'''. Setæ with even margins. Sexual zone sunk.		*O. santi xavieri*, sp. nov.
II' Setæ *a* absent in XVII.		*O. Beddardi* EISEN.
II'' Setæ *b* absent in XVII.		
Prostate minute.		*O. guatemalæ* EISEN.
Prostate large.		*O. sonoræ* EISEN.

Ocnerodrilus (Enicmodrilus) santi xavieri, sp. nov.

Definition.—Length 35-40 mm., width 1¼ mm. Somites about 80. Prostomium divides somite I about one-half. Somite I about twice as wide as somite II. Setæ paired, ventral and dorso-lateral, with smooth margins. No setæ *ab* in XVII. Clitellum saddle-shaped, XIV-½ XIX. Somite IX only a little wider than any other near somite. Sexual zone sunk below the general surface of the body. Male pores on two, hardly elevated, papillæ, in line with setæ *ab*, rounded. The two anterior septal glands of about equal length and thickness; the third pair, in VII, is longer, but narrower; the fourth pair is much the shortest, or about half as short as the third pair. Spermathecæ large, with distinct duct and a pouch with undulating outline. Two pairs of testes and sperm-funnels. A pair of anteseptal, racemose sperm-sacs in IX, and a postseptal, racemose pair, in XI. Sperm-ducts, not thickened near the pores, opening in the same pores as the prostates. The prostates are hardly wider than the sperm-ducts, straight, and not extending beyond the centre of XVIII. No dorsal pores. Meganephridia thickly covered with capillaries; a large cœlomic mantle.

Habitat.—This is the most common earthworm and the only Ocnerodrilide found in Baja California in the vicinity of Loreto and San Xavier. It occurs there in the moist soil in every garden and along every irrigation ditch. Collected June 22, 1899.

Characteristics.—Most of the species of the subgenus *Enicmodrilus* are closely related and only the nicest distinctions serve to distinguish them. *O. santi xavieri* differs from *O. Hendriei* in its spermathecæ, which are much larger, being furnished with a comparatively long, muscular stalk, which is almost wanting in the latter species.

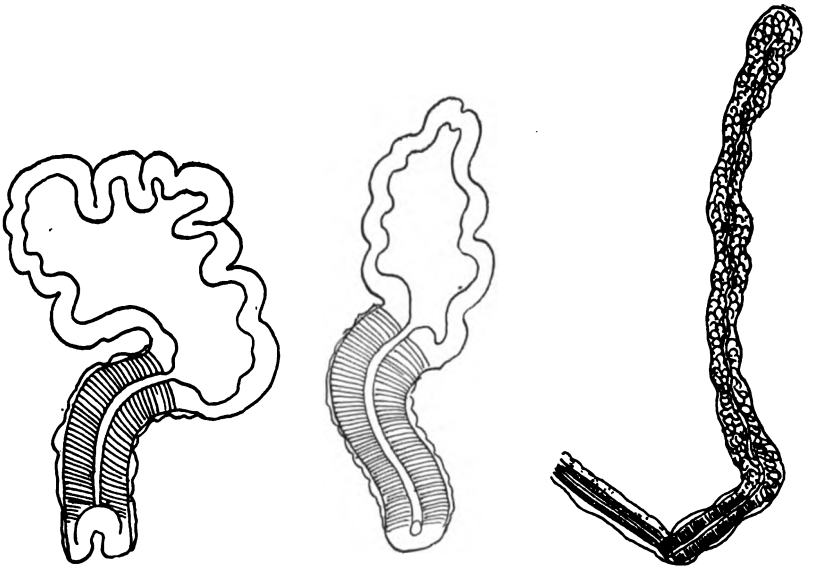
From *O. guatemalæ* the species is distinguished by the absence of setæ *a* in XVII. *O. mexicanus* has no sperm-sacs in IX. The diverticles of the intestine are large and subdivided into longitudinal chambers.

Septal formula:—

IV/V, V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI.

The *sperm-sacs* in IX project from the body-wall near the septum IX/X.

No *ovisacs* are present.



Ocnerodrilus santi xavieri, spermatheca and prostate.

Ocnerodrilus (Enicmodrilus) comondui, sp. nov.

Definition.—Length about 60 mm., width 1¾ mm. Somites 80 to 90. Prostomium divides somite I about one-third. Somite I wider than II or III. Setæ paired, with undulating margins and five to six direct, transverse lines. No setæ *ab* in XVII. Clitellum saddle-shaped, in XIV–XIX. Somite XIX not wider than the other somites. Sexual zone not sunk, except a trifle between the papillæ. Male pores hardly elevated, round, in line with setæ *ab*. Septal glands in VII and VIII of about equal width, those in VI the longest, those in VII a little longer than in VIII. Spermathecæ large, broad and with distinct stalk; the pouch with undulating margins. Two pairs of testes and sperm-funnels. Racemose sperm-sacs in IX and XII; the former preseptal, the latter postseptal. Sperm-ducts not thickened at the pores; prostates

greatly varying in size. In some specimens the glandular part is only knob-like, while in others it is much longer and folded, but does not extend beyond somite XIX. Meganephridia very large, as wide as the somites, the posterior ones with cœlomic mantle.

Habitat.—This species is abundant in the valley of Comondú in the central part of Baja California, Mexico. It is the only Ocnerodrilide found there in the irrigation ditches and in wet soil generally. Collected June 25, 1899.

Characteristics.—The absence of setæ *ab* in XVII and the undulating margins of the setæ bring *O. comondui* near to *O. Hendriei*, from which it differs in having the sperm-sacs in somite IX strongly racemose, and in the form of the spermathecæ and the sizes of the respective septal glands.

The difference between *O. comondui* and *O. santi xavieri* is in the undulating margins of the former and in the nephridia, which are relatively larger than those in the latter form, as may be seen by examining the specimens exteriorly. It is also a larger and especially a thicker worm.

The septal formula, differing from that of *O. santi xavieri*, is as follows:—

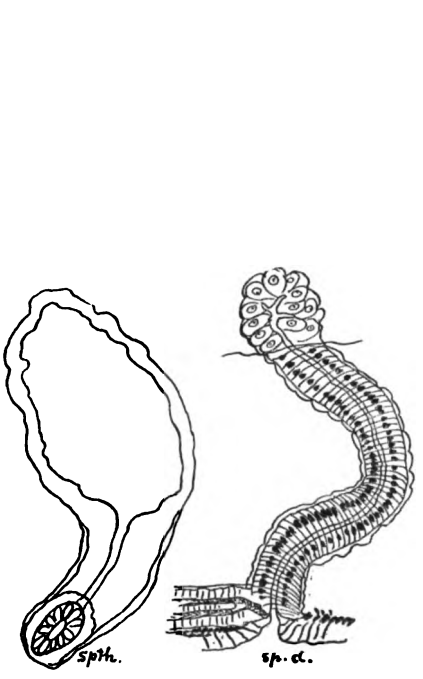
IV/V, V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Sperm-sacs.—The racemose sperm-sacs in IX do not project from the septum forwards, but spring from the body-wall a little in front of the septum on the dorsal side of the body. This is also the case in *Ocnerodrilus santi xavieri*, and perhaps in other species.

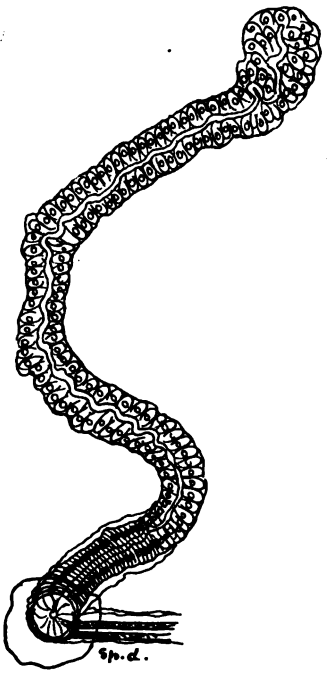
The *sperm-ducts* open in the same pore as the prostates, but do not enter them.

The *prostates* vary more in size than in any other species so far known. In some specimens the glandular part consists merely of a knob-like body, while in others the glandular part is several times as long as the muscular part and extends through somites XVII and XVIII. But as I could see no other differences, both these forms are for the present referred to one species.

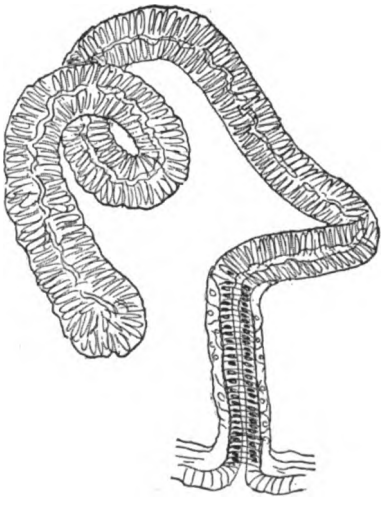
No *ovisacs* are present.



Ocnerodrilus comondui,
spermatheca and prostate.



Ocnerodrilus santi xavieri,
prostate.



Ocnerodrilus comondui, prostate.

Ocnerodrilus (Enicmodrilus) limicola *Eisen.*

Ocnerodrilus limicola EISEN, Proc. Cal. Acad. Sci., 2d Ser., Vol. III, 1893, p. 254.

Setæ.—As Beddard has expressed doubt as to the existence of setæ *ab* in somite XVII, I have re-examined the type and find these setæ to be really absent.

Ocnerodrilus (Enicmodrilus) mexicanus, sp. nov.

PLATE XIV, FIG. 159.

Definition.—Length 45 mm., width 1 mm. No specialized genital zone. The prostates and sperm-ducts open on a pair of small papillæ in XVII, in line with setæ *ab*. Setæ *ab* in XVII are absent. Setæ strictly paired and smooth. Clitellum complete. Spermathecæ, one pair in IX, small, with warty and wavey apex and without diverticle. Sperm-sacs in XII, large and racemose. Sperm-tanks in X and XI. No racemose sperm-sacs in IX. Testes in X and XI. One pair of prostates in XVII confined to one somite; they are small and slender, the glandular part hardly thicker than the muscular part. The sperm-ducts open in the same pore as the prostates. The sperm-ducts are slender and not enlarged at the vicinity of the pores. Septal glands in V to VIII; the glands in VI are the largest; those in VIII the smallest. Sacculated intestine commences in XII. The diverticles of the intestine are long, extending through the whole somite. The nephridia are all furnished with a cœlomic mantle; they are larger from somite XIII posteriorly. The cœlomic mantle consists of two large flat folds overlapping each other in such a way as to appear as one single square mantle occupying the whole width of the somite.

Habitat.—Mazatlan, Mexico, in garden soil.

This species belongs to the group in which the lower part of the sperm-ducts is not enlarged. It differs from *O. Hendriei* in having the septal gland in VI by far the largest, and in the absence of racemose sperm-sacs in IX. It differs from *O. limicola* in having a larger gland in VIII and only one pair of prostates.

Ocnerodrilus (Enicmodrilus) mexicanus *Eisen*, hawaiiensis, var. nov.

PLATE XIV, FIGS. 170, 171.

Definition.—Characters similar to those of the species except in the following: The sperm-sacs in XII are very large, filling the whole cœlom, but they are only very slightly racemose. The spermathecæ are very large; they

extend to the dorsal wall of the cœlom and there is a deep constriction at the center; otherwise the shape is that of the variety. The prostates are very long, extending through ten somites beyond the male pores. Septal formula:

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Honolulu, Hawaii; from soil in pots of plants from the island. Collected by Mr. Alexander Craw.

The nephridia also differ somewhat from those of the species. The cœlomic mantel has the form of a very thick S with the dorsal lobe much thicker than the lower lobe.

Ocnerodrilus (Enicmodrilus) tuberculatus, sp. nov.

PLATE XIV, FIGS. 155 and 156.

Definition.—Length 30 mm., width 2 mm. Somites 104. Prostomium divides somite I into halves; the somite is broader than those behind. Setæ paired, ventral and dorso-lateral with smooth margin. No setæ *ab* in XVII. Clitellum saddle-shaped, in XIII–XIX. Somite IX twice as wide as any other somite. Male pores open on a pair of very large papillæ in line with setæ *ab* in XVII; papillæ with the body-wall about one-third as long as the body is wide. The three anterior septal glands of nearly equal size, slightly diminishing in depth posteriorly; those in VIII the smallest. Spermathecæ, one pair, postseptal in IX, stalked, with a very large globular free apical part. Two pairs of testes and sperm-funnels. Sperm-ducts not thickened at the male pores. Prostates large, extending as far as XXIV. Sperm-sacs large, racemose in IX and XII. No dorsal pores. Meganephridia covered with a few cœlomic, glandular cells which, however, are not in sufficient quantity to constitute a mantle. Anterior nephridia without such cells.

Habitat.—The City of Guatemala, Central America.

This species is readily distinguished externally by the two very large male papillæ which are much more prominent than those in any of the other Central American or Mexican species described so far. The incomplete clitellum and the large size of the worm is also characteristic. The single specimen had become discolored and resembles an Acanthodrilid in the shape of the body.

DETAILED DESCRIPTION.

The most prominent feature exteriorly is the two *male papillæ* replacing the ventral pairs of setæ in XVII. The base of the papilla is much sunk below the general surface,

causing it to protrude from a cavity. The apex of the papilla is furnished with a small pit into which open the sperm-ducts and the prostate, immediately adjoining each other. The spermathecal pores and the ovipores appear to be in line with the ventral setæ.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Septal Glands.—The glands in V are the thickest, the others diminish in thickness posteriorly, so that those in VIII are thinnest. The length (in the direction of the short diameter of the body) of the respective sperm-sacs is, however, very nearly the same.

Intestine.—The tubular intestine is narrow and tubular, its outer walls being parallel where they pass the septa. Between the septa the respective parts of the intestine are greatly bulged out or beaded. The chylus diverticles in IX are long and slender; they originate in the posterior part near the posterior septum. Sacculated intestine commences in XII.

Spermathecæ.—The spermathecæ are postseptal, opening half-way between the setæ and the septum VIII/IX. Their lower or muscular part is cylindrical and very thick, occupying the whole width between the setæ and the septum. The length of each is about one-fourth the diameter of the cœlom. The upper sac is irregularly globular and hangs down over the posterior side of the muscular part, giving the organ somewhat the shape of a smoking pipe. This greatly inflated sac is as wide as two ordinary somites and reaches to the center of the cœlum. The large size of the spermathecæ so increases the size of somite IX that its width is that of two ordinary somites. There is no diverticle.

Sperm-sacs.—The racemose sperm-sacs in IX and XII are of the regulation type and very large, filling the whole of the somites. They have comparatively few lobes, these

being correspondingly large. Large sperm-masses in X and XI.

Sperm-ducts and Prostates.—The sperm-ducts are thick but without any thickened muscular investment. When the ducts enter the papilla they actually narrow down. The prostates are thick and rather straight, the glandular part running back some eight somites. The sperm-ducts and the prostates open at the very apex of the papilla, side by side, the sperm-ducts immediately in front of the prostates. Just before the ducts enter the papilla they do not quite equal in width the muscular part of the prostate. The ducts may be seen running close together within their common investment and do not fuse until they reach the most external pore.

Subgenus **Nematogenia**, subgen. nov.

Ocnerodrilus (Nematogenia) lacuum *Beddard*, **panamaënsis**, var. nov.

PLATE IX, FIGS. 55–65, 114–116.

Definition.—Length 55 mm., width at clitellum 2 mm. Somites 110–120. Setæ strictly paired. Dorsal pores present, those in the clitellum surrounded by a wider depression. No setæ *ab* in XVII. Clitellum in 1/2 XV–1/2 XXII. Septa V–X thickened. The two anterior septal glands well developed, the three posterior ones minute. Gizzards two, very small, in VI and VII; sacculated intestine begins in XIII. Nephridia commence in III, those posterior to the clitellum with cœlomic mantle. Spermathecæ very large in IX. One pair of tests in XI. One pair of sperm-funnels in XI. Racemose sperm-sacs in XII. Ovaries in XIII. Oviducts in XIV. Sperm-ducts, one pair open in XVII jointly with the prostates. One pair of prostates, extending from XVII to XXXIII; in the last three or four somites they are folded.

Habitat.—Four mature and an equal number of immature specimens from Panama, Central America. Collected February, 1896, by Professor Charles H. Gilbert. The specimens were preserved in a five per cent. solution of formalin.

Affinity.—The variety differs from the species from Lagos, Africa, as described by Beddard, in the following particulars:—

Oenerodrilus lacuum *Beddard*, **panamaënsis**, var. nov.	**Oenerodrilus lacuum** *Beddard*.
DORSAL PORES	
begin X/XI.	begin at least VI/VII.
CLITELLUM	
1/2 XV–1/2 XXII.	1/2 XIII–1/2 XXVI.
SACCULATED INTESTINE	
commences in XIII.	commences in XII.
SPERM-DUCT	
not wider at the pore.	slightly wider at the pore.
PROSTATES	
extremely long and folded, extending through 16 somites.	not so long, extending only through 6–7 somites.
LYMPHOCYTES.	
No crenate cells.	Crenate cells.
Nematocytes.	No nematocytes. (?)

(All after Beddard.)

DETAILED DESCRIPTION.

Septa.—The septum farthest anterior is IV/V and is very narrow. There are five specially thickened septa.

Septal formula:—

$$\overline{\overline{\text{V/VI}}},\ \overline{\overline{\text{VI/VII}}},\ \overline{\overline{\text{VII/VIII}}},\ \overline{\overline{\text{VIII/IX}}},\ \overline{\text{IX/X}}.$$

The three central septa are of about equal size and somewhat thicker than the ventral body-wall in their somites.

Septal Glands.—Septal glands are found in somites V, VI, VII, VIII and IX. Those in V are very large, much larger than the suprapharyngeal glands in IV, and about as wide as the muscular part of the pharynx. The glandular mass in V is principally dorsal, ventrally it is very narrow and thin. The septal glands in VI–IX are exceedingly diminutive and cannot be made out by dissection; they are imbedded in lymphatic tissue and amongst agglomerations of lymph-cells; they are confined entirely to the region nearest the intestinal wall and are nowhere as thick as the septa.

Nephridia.—The anterior nephridia do not possess any cœlomic mantles. The posterior nephridia are partly covered by such mantles, the latter being divided in two lobes. One of these lobes is more ventral, consisting of very large cells of a radiating arrangement, the other and more dorsal lobe is much larger, and consists of smaller cells which contain minute opaque globular granules. The lobes are long, narrow and bent backwards. The whole nephridium has the shape of a figure 5. Nephropores in line with and in front of setæ *d*.

Alimentary Canal.—The prostomial lips are small but well defined. The mouth is narrow and may be said to correspond to somites I and II. In line with somite III there is a circular lip, much folded and composed of broad clear epithelial cells, somewhat like the area of taste-cells in *Benhamia*. The pharynx is developed only dorsally. It is very short and its superposed glands are very small and compressed, with their narrow ends projecting forwards. It does not occupy the whole of somite IV but leaves a place for a short piece of the œsophagus at its posterior end. The *œsophagus* turns upwards and occupies one-half of IV and V. The *gizzards* (fig. 56) are in VI and VII; they are very minute, but still perfectly differentiated. The one in VI is a little larger and occupies about one-half of the diameter of the somite. Its muscular layer is slightly wider than the epithelial layer of the intestine. The gizzard in VII is longer and narrower than the anterior one. Its muscular layer tapers gradually towards the septa, and the thickest part of the layer does not extend over one-third of the length of the somite. The gizzards are so narrow that they cannot be distinguished except through sections. They are not wider than the intestine and rather narrower than the œsophagus in V. The *tubular intestine* may be said to extend from VIII to XII. It tapers gradually towards the *sacculated intestine*, which commences in XIII. At the entrance to the sacculated intestine it is furnished with the usual large epithelial folds projecting backwards.

Spermathecæ.—(fig. 57.) The two spermathecæ open in front of the ventral setæ, half-way between them and the septum in somite IX. The muscular duct is somewhat less in length than the pouch. The walls of the latter consist of an inner epithelium of very narrow glandular cells, in which we can distinguish a very large ciliated discharge-pocket adjoining the nucleus. The spermatheca contains not only spermatozoa but also spermatocytes and spermatogonia, having one, two and four nuclei, together with a fine granular secretion.

Testes.—There is only one pair in XI. In longitudinal sections the tests are slightly racemose.

Sperm-sacs.—There is one pair of elongated, well defined sperm-masses in XI, projecting forwards in that somite. They are not surrounded by peritoneum. The real racemose sperm-sacs are in XII. They project from the posterior surface of septum XI/XII, closely surrounding the intestine.

Sperm-ducts and Funnels.—Only one pair of ciliated sperm-funnels and one pair of sperm-ducts. The funnels are large, situated in XI. The sperm-ducts run directly backwards to the male pore in XVII, where they open close to the prostate pores and on the same elevated papillæ.

Prostates.—These organs are larger than in any other species of the genus known. They extend through some sixteen somites and are folded on themselves at the distal end, and would if stretched out extend through three or four more somites. They increase slightly in width from the pore to somite XXXIII; but decrease from that point to the apex. There is a muscular and a glandular part. The muscular part consists of a row of glandular cells, a narrow muscular layer of a few strands, a connective tissue layer with rather large nuclei, and a narrow peritoneal layer of small cup-shaped cells. The nuclei of the latter are small and stain very dark. Towards the distal end of the muscular part the connective tissue layer decreases in size,

while the glandular layer increases. Hence the muscular duct is composed of two sections, each section occupying two somites. The part which is most glandular contains two different kinds of alternating glandular cells. The narrow cells are similar to those in the muscular prostates; the larger ones resemble those in the glandular part. In the glandular part there is only a single row of glandular cells, commencing with somite XXI.

Lymphocytes.—(figs. 114–116.) The free cœlomic cells of this variety are of more than usual interest, one kind being a most extraordinary structure. The following kinds are distinguished.

Nematocytes.—This name is proposed for a highly specialized lymphocyte found in great numbers in the lymphatic fluid of this species. These cells are erythrophile, staining intensely with eosin and fuchsin. *The whole cytoplasm is filiform and takes the shape of a single, continuous, narrow strand wound regularly like a coil of rope.* Seen from the flat side these cells are irregularly rounded. The winding of the strand begins at one end or surface and continues regularly, ending at the other surface-end or pole. Where the cells had been torn, it was frequently found that a portion of the nematocyte had been carried some distance away without any break in the cytoplasmic thread, part of which could be seen more or less uncoiled, connecting the two portions of the cell. In many instances the beginning and the end of the thread could be clearly seen. The first coils nearest the pole are narrow, but they gradually widen until they reach their greatest diameter, which is that of the cell; then again they gradually diminish and finally end as they began. The thread does not contain any microsomes of unequal size, but there is some differentiation, so that alternating divisions stain darker. These alternate divisions appear to be of the same size, but are so minute as to be but indistinctly seen. In optical section the thread is round. The nematocyte is not covered by an exterior membrane (cytotheca), but the boundary of the cell consists always of the margins of the cytoplasmic rope. There is no cytoplasm

visible either inside or outside of the cytoplasmic rope. The latter did not fill the centre of the cell, there being always more or less space not occupied by the thread and the nucleus.

The nucleus is oval, slightly irregular, with a central contraction.

A cœlomic cell somewhat resembling the nematocyte has recently been described by Edwin S. Goodrich from the lymph of *Enchytræus hortensis*.[1] Mr. Goodrich has figured a number of these cells and demonstrated their minute structure in detail. They differ from the nematocyte of *Nematogenia lacuum* var. *panamaënsis* in having a distinct cell-wall and in having the nucleus placed outside instead of inside of the rope-coil, which is much less regularly coiled.

In the *Enchytræus* cells the rope appears as a secondary structure in the cytoplasm, while in the *Nematogenia* cells the rope itself is the cytoplasm and *all* the cytoplasm there is in the cell. The rope may, perhaps, serve to catch bacteria, sperm-fragments and other foreign substances in the lymph. The function of the rope in the *Enchytræus* cells is unexplainable, unless we presume that it is now and then ejected outside of the cell-wall, serving as a lasso for catching microbes, or for attachment. Cells corresponding to the supposed early stages of the *Enchytræus* cells as figured by Goodrich are nowhere to be seen in our *Nematogenia*. Goodrich has also figured (figs. 13 *e* and 14) cells which greatly resemble the amœbocytes from the *Ocnerodrilus* lymph; these cells he describes as thread-cells under the action of water and caustic potash. Similar cells are found in our *Nematogenia*, but I do not believe that they are stages of the nematocytes. They are comparatively few in number and are much smaller than the nematocytes; they also possess a centrally located nucleus, while the amœbocytes figured by Goodrich have no nucleus, but are evidently structures separated from it. No suggestions offer themselves as to the origin of the nematocytes.

[1] Quart. Journ.. Mic. Sci., Vol. XXXIX, Pt. 1, May, 1896.

Mucocytes.—The round cyanophile cells found in great numbers in the lymph are probably referable to the class called by Dr. Rosa mucocytes. They are, however, perfectly round and have not the projections figured by Rosa. They are of the same size as the nematocytes but are spherical and even in outline, and furnished with a cell-wall. The nucleus is round with a central nucleolus. The mucocytes are more numerous than any of the other cells and appear to originate in a special lymphatic tissue intimately connected with the septal glands in VII, VIII and IX. It is not found surrounding the glands in IV, V or VI. The real septal glands in VII–IX are small, but appear much larger than they are on account of this lymphatic layer, which closely and intensely surrounds the cellular tissue of the glands. The differentiation is best brought out by a double stain of Rubin S. and Toluidine blue, the gland staining dark blue and the lymphatic tissue pink with blue nuclei. The cells composing this lymphatic tissue are not as round as the mucocytes. There are large numbers of the latter embedded in the tissue, especially at the edges, where probably they originate, though I have not seen any of them in mitosis.

Amœbocytes.—These are small star-shaped bodies with minute and numerous thread-like pseudopodia. These rods or threads are probably the amœboid projections of the cell itself, but the whole structure is too small to be studied in detail. They stain but poorly, and are less readily studied than the nematocytes.

Subgenus **Ilyogenia** *Beddard.*

Ocnerodrilus (Ilyogenia) taste *Eisen.*

PLATE XIV, FIGS. 157, 158.

Phœnicodrilus taste EISEN, Mem. Cal. Acad. Sci., Vol. II, 1895–96, Nos. 4 and 5.

Habitat.—In the immediate vicinity of the city of Tepic, Mexico, at an altitude of 4,000 feet. Also numerous specimens collected by Prof. Albert Koebele in the vicinity of

the City of Mexico and at Morelos, Mexico. In the latter district they were found in the pine timber at an altitude of 6,000 to 7,000 feet.

NOTES ON THE TEPIC SPECIMENS.

Upon dissection, one of the specimens which had previously been overlooked and referred to *Ocnerodrilus tepicencis* was found to agree in all the principal points with *O. taste* from the Cape Region of Baja California. Both species are characterized by the absence of the ovisac, the small clitellum in XIV–½ XIX, and by the short, thick, and warty spermathecæ, although in *O. tepicencis* they are very small and do not occupy more than one-fourth the width of the somite, while in the type-specimens from El Taste they are larger, extending fully to the posterior part of the somite (fig. 135). In *O. taste* there is not the distinct, star-like, radiating zone found in somite XIV of the other species. The specimens are large and fully mature, and it is therefore not probable that the spermathecæ are undeveloped.

NOTES ON THE SPECIMENS FROM THE CITY OF MEXICO.

The specimens from the City of Mexico differ in some respects from those from the type-locality—the mountains of Baja California. There is no star-shaped papilla in somite XIV, in line with setæ *cd*. The spermathecæ are a little smaller and the outline of the sac-like part is more even, the undulating margin being confined to the apex of the sac. The sperm-sac in IX is furnished with some six to eight lobes, which are less minutely racemose than in the type. In X and XI sperm-masses only are found. This seems to be a common characteristic of most of the species. The sperm-sacs in XII are also racemose, long and narrow, and postseptal. There is absolutely no trace of any prostates. The two sperm-ducts run close together until they reach a point just above the male pore, when they fuse and become invested with a heavier coat of muscles. They

then dip down through the muscular layers and form a small atrium about half as wide again as the sperm-ducts and equaling in thickness that of the epithelium of the clitellum at that place.

Kerria *Beddard.*

Kerria McDonaldi *Eisen.*

Habitat.—A pond near Santa Ana, Cape Region, Baja California, Mexico.

The specimens resemble very closely those found at Miraflores, Baja California. One of the specimens was sectioned, enabling me to add a few particulars to the former description. The intestine possesses a very rudimentary gizzard in somite VII. The circular muscular layer is here about twice as thick as in the somites preceding and following, and altogether the intestine in that somite is about one-third thicker than elsewhere. The single pair of sperm-funnels is in X. There are no sperm-sacs in any of the somites, only sperm-masses in X and XI.

EUDRILINÆ.

Eudrilus *Perrier.*

Eudrilus Eugeniæ *(Kinberg).*

PLATE VII, FIGS. 27-34; PLATE VIII, FIGS. 40-48; PLATE IX, FIGS. 49-50.

Habitat.—The specimens upon which my investigations are based are all from Panama, where they were collected in January, 1896, by Professor Charles H. Gilbert. They were preserved in a five per cent. solution of formalin, and were in very good state of preservation, suitable for histological purposes. Judging from the number of specimens in the collection, this species must be the most common of the large terrestrial earthworms in Panama.

Nomenclature.—For convenience sake I have here adopted the definition by Beddard and referred the present species to *Eudrilus Eugeniæ* (Kinberg), though I am satisfied that there are differences sufficient to warrant the making of at least a new variety. In a species so widely distributed as *Eudrilus Eugeniæ* we may expect to find interesting variations. In the following pages I have noted down the principal anatomical differences between my specimens from Panama and those upon which Beddard bases his definition; there are also added some observations on the finer anatomical and morphological structure.

EXTERNAL CHARACTERS.

Body.—(figs. 27–34). The body of the worm tapers gradually towards the tail which is very thin and pointed. Length from 120 to 150 mm. Color reddish to violet brown above, with fine and strong violet iridescence. Below yellowish white with some iridescence.

Somites.—(figs. 27, 28). The prostomium divides somite I about one-half to two-thirds. Somite II is about one-fourth smaller than I or III; somite III is about one-third smaller than IV; and IV is somewhat smaller than II and III combined. Somites III, IV and V are somewhat longer.

Nephropores.—The most anterior pore is in VI, in front of setæ *cd*. The pores in X to XIII are surrounded by an elevated glandular ring.

The *ovipores* are in front of *cd* in XIV.

Copulatory Organ.—(figs. 29–33). The male pores are found in the posterior part of somite XVII in line with setæ *ab*. There is a very large eversible bursa-copulatrix into which open the penis and the copulatory papilla. On this papilla we find the external pore of the Y-gland, while at the apex of the penis we find the opening of the prostate duct. When the bursa-copulatrix is retracted, the end of the penis projects through the opening of the male pore. When this bursa is everted the whole penis, as well as the

very large papilla of the Y-gland, is free. Owing to contractions and contortions of the worm, it is difficult to illustrate the true position of these exterior organs (figs. 29–33). The papilla of the Y-gland is very large, filling nearly the whole of the bursa-copulatrix. It possesses only one pore, the one which communicates directly with the duct from the Y-gland. The penis is variable in regard to its curvature, but it is always so situated that its exterior groove can be readily brought opposite and close to the opening pore of the Y-gland. When viewing the papilla of this gland from the exterior there appear to exist two external pores of the gland, the papilla being pointed at both ends and quite symmetrical. Sections show, however, that there is only a single pore, which is always situated on the side nearest the exterior groove in the penis. This groove in the penis does not extend to the base of that organ, but only about half-way down its length. The groove is connected with the lumen of the penis near its apex only and not at the base also, as described by Beddard.

INTERNAL CHARACTERS.

Nephridia.—The nephridia are very thin, slender, and even, occupying a narrow zone along the septa. Those posterior to the clitellum are long and covered for their entire length with a thick but even agglomeration of round granular secretions of different sizes. These globules stain intensely with aniline colors. The granules are confined in a sac-like tissue, the surface of which is racemose. It extends from top to base of the nephridium, but only along one of its sides. The nephridial cœlomic sac, which follows the almost parallel lobes, is narrow and even, and occupies about one-fourth of the width of the somite.

Suprapharyngeal Gland.—The usual suprapharyngeal glands are present and well developed. When viewed in longitudinal sections they are seen to consist of five distinct lobes, one posterior to the other. The most anterior lobe is the smallest and the most posterior lobe the largest. Each

lobe contains a central muscular bundle connecting the pharynx with the body-wall. Glandular cells surround these muscular strands on all sides. The muscles to which the most posterior lobe is attached run backwards to the junction of somites VII and VIII.

Subintestinal Vessel.—(figs. 39, 42). Beddard describes and figures this vessel as being double in somites X and XI. In my *Eudrilus* from Panama the vessel is single, judging from an examination of an unbroken series of transverse sections. It is surrounded by a zone of lymphatic tissues (fig. 41) in which are seen a number of lymphocytes. Immediately surrounding this vessel the tissue forms a thick, even coating, which ventrally spreads out as a lamella on either side (fig. 42). Under high power the tissue is seen to be highly vacuoled, with two kinds of nuclei and here and there a lymphocyte. The vessel connects directly with the blood sinus in the median diverticle of the intestine. The ventral side of the diverticle consists similarly of a spongy tissue with numerous vacuoles separating the epithelial linings. In this tissue we also find two kinds of cells, some with much smaller nuclei than the others.

The last hearts are in XI. The hearts in IX, X, XI are of about equal size; those in VII and VIII are smaller, the former being the smallest.

Diverticles of the Intestine.—These hearts are well developed, as has already been mentioned by several investigators, especially Beddard. There is one point in which the specimens from Panama differ from those of Beddard. He describes the entrance of the diverticle into the intestine as very wide, while in my specimens this duct is very narrow (figs. 39, 40). In both of the median diverticles I find large agglomerations of lime, a few of which are shown in fig. 41. In the paired diverticles in somite XII neither crystals nor any lime globules are to be found.

Female Generative Apparatus.—(figs. 49, 50). This complicated apparatus differs considerably in details from the wood-cuts and descriptions given by Beddard. The

oviducal pore is situated in front of setæ *cd* in XIV. Into this pore opens a very large, somewhat coiled spermathecæ, which is bent on itself. The part which is nearest the pore is situated in XIV, but the largest part is found in XIII. Into this spermatheca open three different ducts, within a short distance of each other. The place where these ducts open into the spermatheca is found about one-third the distance from the pore to the inner apex. The ducts which open into the spermatheca are those of the oviducal gland, the anterior oviduct and the posterior oviduct (figs. 49, 50, *ov.* 1; *ovd. gl.* and *ov.* 2 and *ov. s.*). The anterior and posterior oviducts differ in size and function. While the anterior oviduct conducts the undeveloped egg-cells, the posterior oviduct conducts not only the undeveloped egg-cells of the anterior ovary into the ovisac, but also the ripe ova from the ovisac to the spermatheca. The posterior ovaries, which are situated much higher up, are also the largest. As Beddard has pointed out, these ovaries serve also as ovisacs. The ovaries in XIII are rudimentary and furnish only immature ova. The young egg-cells from these ovaries slough off in bunches and are carried through the narrow anterior oviduct (figs. 49, *ovd. ov.* 1) to the base of the spermatheca; thence they are probably carried to the posterior ovisacs, there to go through maturation. In the ovisacs we find ova in all stages of development. There are free bunches of egg-cells, as well as cells attached to the walls of the ovisacs, and it seems there can be no doubt as to the double nature of the ovisac, it being both ovary and an ovisac. The long coiled oviduct is not ciliated, but we find cilia in the funnel of the oviduct, which connects directly with the ovisac. The funnel and the coiled oviduct are entirely in XIII, but the part of the spermatheca into which it opens is in XIV. Beddard states that the oviduct penetrates the septum XIV/XIII twice. This is not the case in the *Eudrilus Eugeniæ* from Panama, as has just been shown. The egg-cells in the posterior ovary and ovisac are not placed as in Beddard's figure (Pl. XX, fig. 53), but they are found all along the inner margins of the walls of the ovisac, in the manner figured (fig. 49, *ov.* 2).

The lower part of the spermatheca is much wider in my specimens than in Beddard's, judging from his figure referred to above. The figures representing the female reproductive system were drawn from a number of sections, (fig. 49 from longitudinal, fig. 50 from cross-sections). They are, of course, partly diagrammatic, but it was the endeavor to reproduce the relative proportions as faithfully as possible.

As regards septum XIII/XIV, it was found to be perfect all along the body-wall and between it and the female organs. In the center, however, it is defective or entirely absent.

Male Apparatus.—(figs. 44, 48). This very complicated set of organs differs somewhat from the description and figures of *Eudrilus sylvicola (Eugeniæ)* as given by Beddard. In a general way, Beddard's description fits the specimens in question, but the positions of various parts is different. In one respect, however, Beddard is in error, provided, of course, that we have studied the same species. Beddard states (62) that the longitudinal groove of the penis opens into the lumen of that organ. This is not the case in the *Eudrilus Eugeniæ* from Panama. The penis possesses a groove just as stated by Beddard, but it does not open into the canal of the penis at the junction with the bursa, it simply ends bluntly at the base, while at the apex it joins with, and ends at, the exterior opening of the canal of the penis. The groove is therefore entirely an exterior structure along its whole length. Its object is not difficult to perceive. Because of its peculiar position the groove can readily be brought close to the pore of the Y-gland, as shown in figs. 44 and 46 at X. Any discharge from the gland at any point from the base to the apex will therefore be caught in the groove and conducted to the orifice of the penial canal, there to be mixed with the exuding contents of the prostates.

Four specimens were sectioned in order to ascertain the structure of this organ and all were found to closely agree. In every instance the pore of the Y-gland was found to be

situated close to the groove in the penis. At times the pore was found near the base, this always being the case when the muscular cushion was retracted. When the latter was more or less extended, the pore was found nearer to the apex of the groove. The secretion of the Y-gland when coagulated is tough and resembles, superficially at least, the secretion from the silk glands of a caterpillar. In many of the specimens the secretion of this gland has been ejected, forming a very thin flattened string several inches long, either hanging down along the side of the body or twisted and rolled into a ball around the copulatory cushion. Quite a little force is required to break this thread. The thread stains but poorly with hæmatoxylin and methylene blue, and cannot therefore be of a strictly mucous nature. It shows a fine longitudinal striation, as if consisting of innumerable fine strands. The pore of the Y-gland is round and possesses but a single opening. The pore is also connected with a tiny groove which runs parallel (and opposite) to the groove in the penis, but which is much shorter. The upper end of the Y-gland is muscular, the two forks are separate as regards their lumens, but they are surrounded by a common muscular covering of great thickness. According to Beddard's figures the prongs of the gland are longer than the canal, the prongs joining close to the wall of the bursa. In my specimens the Y-gland possesses a longer duct, as shown in fig. 44, *y gl.* This duct is very much curved and enters the bursa from the ventral side of that organ, while Beddard's figures indicate that the Y-gland enters the bursa from its dorsal side.

Prostates.—In my specimens the longer prostate is about twice as long as the shorter one and must, I think, be the main prostate, while the shorter part may be called a diverticle of the other. These two parts cannot well be considered as two distinct prostates joined together, on account of the difference in structure, which, though slight, seems of sufficient importance to be considered.

Thin sections of the two parts of the prostates are found to stain differently, one taking the stain much more readily

than the other. The contents of the diverticle also stains intensely with red stains, but I have found no such dark staining secretion in the larger part of the prostate. There is also a difference in the structure of the glandular cells in the two parts. Those of the diverticle are larger, more twisted and bent, while those of the main prostate are smaller and straighter. In the main prostate the epithelial layer is surrounded by a narrow muscular layer which winds in and out between the glandular cells, but in the diverticle this muscular layer is reduced to a very few strands not readily perceived.

The muscular coat surrounding the prostates is exceedingly powerful. It consists of three layers of which two are entirely distinct. The outer longitudinal layer surrounds a narrower transverse muscular layer, and this is lined interiorly by another very narrow, but still recognizable longitudinal layer, which here and there runs off to the prostates, separating the diverticle from the main gland. The two inner muscular layers are not always to be distinguished one from the other and are probably only differentiated parts of one layer. The width of the diverticle is greater than that of the inner prostate. In cross-sections it will be seen that the diverticle embraces the main prostate like a crescent and occupies the largest space inside the common muscular coat.

The secretion from the diverticle appears to be of a twofold nature. There is a thin cyanophile mucous secretion and a thicker erythrophile one. The latter is generally found in the shape of irregular rounded granules or globules surrounded by the cyanophile secretion.

Judging from Beddard's figure (62, fig. 10), the difference in the size of the two glands is not great. In my specimens the longer part of the prostate is much narrower, occupying a comparatively small space within the muscular coat.

The globular enlargement of the sperm-duct at the ciliated funnel resembles exactly the figures given by Beddard, but the funnel itself is somewhat different. In Beddard's

figure we see broad and narrow lobes alternating, while in my specimens all are of the same size, the lobes being broader and regular.

Sperm-ducts.—These are very thick, and are separated to the junction by the prostate. They enter the prostate covering in the vicinity of the apex of the diverticle, run for a short distance inside the covering, and then pierce the main prostate, just in line with the apex of the diverticle. The ducts curve inwardly and enter the prostate in the center of the organ, as seen in a section represented in fig. 47. The two ducts unite only in the glandular part of the prostate. Anteriorly the ducts run forward in a straight line, curving only over the large muscular bursa.

Epidermal Sense-cells.—(figs. 95–97). As is well known, many and perhaps all species of the genera of Eudrilidæ are characterized by the possession of large epidermal sense-cells, which Beddard has compared to the pacinian bodies of higher animals. He has figured and described these cells (54) in *Eudrilus*, and any further description would seem to be superflous. But the sense-cells found in the *Eudrilus* from Panama differ so much from those Beddard describes that it seems likely that we have investigated two different species. Judging from Beddard's papers (54, figs. 2 and 3; and 62, fig. 14) it appears as though the structures of the various cells composing the so-called pacinian body do not differ much from each other. In fig. 14 we find a large central nucleus surrounded by a rather small cell, around which are seen a number of thin concentric cells with nuclei of much smaller size than the central one. This is the case in Beddard's species from Guiana. In my Panama specimens, the sense-cells are situated exactly as described by Beddard, at the base of the epidermis; they never reach more than about half-way up to the cuticle. The sense-corpuscle is surrounded by ordinary glandular and supporting cells, which shut off the former from the cuticle. In a general way the sense-corpuscles may be described as consisting of a very large central cell, which is

capped and partly surrounded by from three to twelve very thin but wide cells superposing each other (figs. 95, 96). A characteristic feature of each one of these upper cells is the situation of the nucleus, which is found on or near a line passing perpendicularly from the cuticle through the large central cell. There is no constancy in the size of the nuclei. Beddard states that the central nucleus is very large and that the other nuclei are small. While I have found corpuscles in which the central nucleus was much larger than the upper ones, in many instances the reverse has been the case. The upper nuclei are generally of very even size.

When seen in a cross-section of the body of the worm the sense-corpuscle is sac-like, generally higher than broad (fig. 95). In longitudinal sections (fig. 97) the sense-corpuscle is longer than high. The most interesting feature of the sense-corpuscle is the structure of the large central cell. Its size varies considerably, as may be seen by the figures, but it is always larger than all the upper cells combined. There are two very prominent characteristics of this cell: the nucleus is situated in, and suspended by, a diaphragm which forms a constant acute angle with the base of the cell and the cuticle of the deric epithelium; secondly the cytoplasm of the cell is laminated in a certain and distinct manner (figs. 95–97).

The central nucleus is evidently capable of extention and contraction, as in some cells it is found to be much elongated in the direction of the diaphragm, while in others it is quite round. In some cells the diaphragm has the form of a simple bar, dividing the vacuole into two equal parts; but in reality this diaphragm consists of a number of narrow lamella which in the figure are only seen in cross-section. The other ends extend to the opposite side of the vacuole somewhat in the manner of a membrane stretched on a drum. More strictly speaking, there are two central vacuoles separated by a diaphragm, and surrounding them is a dense mass of peculiarly laminated cytoplasm. Cross-sections show that this lamination does not extend all around the

cell, but is discontinued in the direction of the diaphragm both upwards and downwards. The lamellæ are very distinct and of even thickness throughout until a certain zone is reached, where they spread and thin out, each lamella continuing towards the cell-wall as a thin, wavy, cytoplasmic thread. In several cells there could be distinctly perceived a thinner continuation of the central cell downwards into the muscular layers, probably indicating a connection with nerve-fibers.

Beddard has given a diagrammatic drawing of a "pacinian corpuscle" of *Hyperiodrilus* (No. 54, Pl. XVI, fig. 4) from which it appears there were a large number of nuclei in the central core. In the sense-corpuscles of *Eudrilus Eugeniæ* from Panama there certainly does not exist any structure similar to that just described. On the other hand, I find some resemblance between these cells and the supposed auditory cells of *Pontoscolex* described elsewhere in the paper. In both of these cells the cytoplasm shows a very high degree of differentiation. There is in each cell a central nucleus and a diaphragm, the latter being of different structure in the two cells. In *Eudrilus Eugeniæ* there is no body comparable to the otosome; but still there is enough resemblance to suggest a possible or even probable similarity of function. Since the manuscript of the first paper (Eisen 19) on *Pontoscolex* passed out of my hands, Dr. R. Hesse (2) has described a most interesting type of sense-cells from the epidermis and nerve-ganglia of Lumbricidæ. Dr. Hesse recognizes in these cells organs for the perception of light.

In *Pontoscolex* and *Eudrilus* the sense-corpuscles are not found in increased numbers in the anterior and posterior somites, but on the contrary are more numerous in the central parts of the body, or in parts much less exposed to light. If the sense-corpuscles in *Eudrilus* and *Pontoscolex* are organs for light, we should expect to find them more numerous in parts of the body most readily exposed to the light, such as the tail and the prostomium; but in these

parts they are, on the contrary, very rare or absent. Sense-cells in the central part of the body are likely to serve some other purpose.

We have seen that Oligochæta possess cells perceptive of light, taste, smell, and touch, and unless we assume the existence of a sixth sense not present in the higher animals, the only remaining sense not yet fully recognized in Oligochæta is that of hearing. The nature of the structure of the sense-cells in *Pontoscolex* and *Eudrilus* is such as not to oppose the assumption that in these cells may be recognized primitive auditory organs. In *Pontoscolex* the characteristic parts of the auditory cell are the otosome and the diaphragm. In *Eudrilus* the diaphragm only is present, but it does not seem improbable that the almost vertical column of nuclei superposed on the large lower cell may serve as a row of otosomes, aiding materially in carrying along the sound-waves to the diaphragm of the more sensitive cell below. It is of the utmost importance that the worms be enabled to perceive sounds caused by the feet of birds, the working of moles and other animals,—sounds which must be transmitted through the soil in order to reach the worms.

The situation of the sense-corpuscles in the projecting equatorial of each of the more central somites in those parts of the body which come into closest contact with the soil, seems to me to especially favor the theory that these cells and corpuscles are really organs for the perception of sound. Not only are these cells more numerous in the equatorial of the central somites, but they are nearly exclusively found on the dorsal and lateral sides of each somitic equatorial, and are almost absent on the ventral side. In other words, they are most numerous in parts most accessible to sound-waves passing through the soil, and are singularly scarce in parts which are least accessible to these sound-waves. These cells in *Eudrilus Eugeniæ*, as well as in *Pontoscolex*, are found several rows abreast in each equatorial, and are never found outside of the equatorial.

ACANTHODRILINÆ.

Notiodrilus *Michaelsen.*

With Dr. Michaelsen (30) I agree to place the American species of the old genus *Acanthodrilus* in a separate genus. As Dr. Michaelsen's paper (30) arrived just as this manuscript was going to press, there was no time to discuss the subject; I can merely state that in most respects Dr. Michaelsen's re-arrangement of the genera of this family seems admirable.

Notiodrilus Whitmani, sp. nov.

PLATE XIV, FIGS. 163-167.

Definition.—Length 60 mm., width 2½ mm. Somites about 115. Setæ paired. Penial setæ very large, smooth, with end knob. No spermathecal sexual setæ. Clitellum small, saddle-shaped, XIII-XVI. Prostomium divides somite I, about one-half. Genital zone not prominent. Groups of four to six small papillæ in the intersegmental grooves of IX/X, X/XI, XI/XII, in line with the lateral intervals on each side. Intestine without any diverticles. Gizzard in VI. Sacculated intestine commences in XIV. Two pairs of spermathecæ, the anterior pair smallest, each with a single diverticle of large size. The spermathecal pores are postseptal. Sperm-sacs racemose, in IX, XI and XII. Loose sperm-mass in X. Testes in X, XI; sperm-funnels in X, XI. Ovaries in XIII, oviducts in XIV. Prostates long, narrow, tubular, much coiled in one plane, each covering two somites. Sperm-ducts do not fuse until the male pore in XVIII. Meganephridia; no peptonephridia. Last hearts in XII. Color pale flesh, without pigment.

Septal formula:—

$$\overline{\text{VI/VII}},\ \overline{\text{VII/VIII}},\ \overline{\text{VIII/IX}},\ \overline{\text{IX/X}},\ \overline{\text{X/XI}},\ \overline{\text{XI/XII}}.$$

Habitat.—Coban, Guatemala, Central America.

This species is very abundant in the river near the city of Coban, in the highlands of Guatemala. I found it in the banks of the river, among the roots of plants, etc. It is not strictly an aquatic form. The species is named in honor of Professor C. O. Whitman, to whom the author is indebted for many courtesies.

DETAILED DESCRIPTION.

Glands.—There is a pair of small septal glands in VI and VII, about as long as the spermatheca is wide. There is a tiny subpharyngeal gland. There is no septum anterior to that separating VI and VII.

The *gizzard* is strongly developed, but confined to somite VI. There are very few and only very small chloragogen cells anywhere.

The *sperm-sacs* are all racemose, but the anterior pair is less racemose than the two posterior pairs. All three pairs are postseptal.

The *spermathecæ* are of somewhat less height than the diameter of the body. The anterior pair is considerably narrower than the posterior pair; this is true of both the main sac and the diverticle. In the anterior pair the diverticle is of the same length as the main sac, but a trifle straighter and a little thinner. This diverticle is divided up into imperfect chambers, due to some parts of the epithelium being longer than others. The posterior diverticle is less marked in this respect. The main sac of the spermatheca contains a much narrower epithelium, which is smooth and even. The diverticle joins the main sac at the base of the muscular duct. The diverticle of the posterior spermatheca is about two-thirds as large as the main sac of that organ.

The *prostates* are thin and tubular, but greatly coiled, principally in one plane. The glandular part is perhaps ten times as long as the muscular duct. There are two kinds of cells in the glandular part, but they do not form two distinct layers as in so many other species. The larger, very glandular cells reach from the outer to the inner wall and are only one layer thick. Similarly, the thinner supporting cells which separate the glandular cells reach from the inner lumen to the outer surface of the organ, very much in the same way as in some species of *Diplocardia*. The prostates open slightly dorsal to the penial setæ.

The sacs with *penial setæ* are very large, about as long as three somites. The two sacs at each pore are joined along their entire length; they consist of a larger sac-like part which encloses the setæ, and a shorter, narrower, and tubular part, serving as a duct for the guidance of the seta when it is projected. This duct is about one-third as long as the main seta-sac, towards which it is sharply bent or even closely folded. The two ducts of the respective setæ are closely joined, but not fused, and remain thus to the very pore. The setæ are of different forms. The longer is a little more curved, and its apex, which is much narrower, is bent towards the main part like a fish-hook. The shorter seta is only a trifle shorter. It is less curved and the tip is narrower and only slightly bent. Both setæ are smooth and have a small knob at the apex. The knob is not quite smooth, being furnished with a few depressions and elevations.

The *common setæ* are strictly paired, and measured with a micromillimeter scale give the following comparative values:—

a–a=110; a–b=12; b–c=90; c-d=10.

Notiodrilus cristalifer, sp. nov.

Plate XIV, Figs. 160–162.

Definition.—Length 20 mm., width 1 mm. The anterior seven somites smoother than those posterior. The genital zone is sunk as in *Benhamia*. The prostates in XVII and XIX open on prominent papillæ. Setæ strictly and closely paired, all ventral. Penial setæ slender, not ornamented. Nephropores in front of setæ *d*. Diverticles of the intestine in VII, VIII, IX. Sacculated intestine in XII; gizzard in V. Spermathecæ in VIII and IX. Testes in X and XI. Racemose sperm-sacs in XII, very minute and ventral. Plain sperm-sacs in IX. Sperm-funnels in X, XI; sperm-ducts not fused until the male pore. Prostates confined to their own somites. Meganephridia, with numerous lime crystals. No typhlosole. Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Tactic, near Coban, in Guatemala. One specimen, July 4, 1882.

This little species of *Notiodrilus* is well characterized by the position of the diverticles of the intestine in somites VII, VIII and IX. Nearly all other species of this genus have the diverticles much farther back, generally posterior to XIII. *N. cristalifer* is readily distinguished by the form of its spermatheca from *N. tamajusi*, also from Guatemala, the only other species so far known which has the intestinal diverticles in the same somites. *N. tamajusi* has the penial setæ ornamented at apex. *N. Whitmani* has no intestinal diverticles.

DETAILED DESCRIPTION.

Dorsal pores present; the most anterior one IX/X (?).

Glands.—The suprapharyngeal glands are in six lobes, the most anterior one being very minute. There is no trace of any septal glands.

Calciferous Diverticles.—The calciferous diverticles of the intestine occupy the ventral or latero-ventral part of the intestine in somites VII to IX, and constitute merely thickened folds or swellings of the intestine. They possess, however, the same internal structure as diverticles of other species, that is, their interior cavity is divided by numerous, more or less parallel, folds of the inner epithelium. In a vertical section of the intestine it is seen that these folds are confined to the ventral part, gradually diminishing laterally, and entirely absent on the dorsal side, where the walls of the intestine are characterized by large blood-sinuses.

The *spermathecæ* in VIII and IX are medium sized, slender sacs, each with a small tubular diverticle pointing forwards, but confined to the somite of the spermatheca.

The *sperm-sacs* in IX are large, filling the whole somite. They are surrounded by a peritoneal membrane but are without trabecula. The racemose sperm-sacs are in XII; they are very small and confined to the lateral and ventral sides of the cœlom.

The glandular part of the prostate is large and bent zigzag, but is confined to the somite into which it opens. There are two distinct layers of cells.

The *clitellum* was not developed in the immature specimen at my disposal.

The *penial setæ* are without ornamentation, except for a small fin-like flare at the very apex. The apex of one of the setæ is furnished with a tiny hook, below which on the curved side is situated the flare. The other setæ is without the hook but possesses the flare.

The *nephridia* are large meganephridia opening in front of setæ *d*. They are characterized by numerous—from 30 to 60—minute crystals, probably of lime, strung out along the whole length of the nephridium. Similar crystals, but twice the size, are found in the sacculated intestine. None are in the diverticles of the tubular intestine. The dorsal part of each nephridium is covered by a cœlomic mantle extending about one-third down the nephridium.

The *septa* between VII and X are thickened both dorsally and ventrally, but the septa between X and XIII are thickened principally ventrally.

MICROSCOLECINÆ.

KEY TO THE SPECIES OF *Microscolex*, *Yagansia* AND *Rhododrilus*.

A. Two pairs of testes.

Microscolex *Rosa*.

I. Two pairs of testes. No spermathecæ.

1. No gizzard. Nephridia commence in V. Sperm-ducts join the center of the muscular part of the prostate.
Microscolex dubius (FLETCHER, 3).

2. No gizzard. Nephridia commence in II. No septal glands; suprapharyngeal glands small. Sperm-sacs in XI and XII. Sperm-ducts join the prostate at the exterior pore.
Microscolex Poultoni BEDDARD (38).

3. Gizzard rudimentary. Nephridia commence in II. Septal glands small; suprapharyngeal glands large. Sperm-sacs in XI and XII. Sperm-ducts join the prostate in the body-wall, previous to entering exterior pore. Nephropores with sphincter.
Microscolex elegans (EISEN, 16).

4. Gizzard rudimentary. Nephridia commence in II. Racemose sperm-sacs in XI and XII. Anterior setæ not converging; posterior converging. Sperm-ducts join prostate before they enter the body-wall, half-way up the muscular part. Nephropores without sphincter.
Microscolex carolinæ, sp. nov.

II. Two pairs of testes. Spermathecæ present, with one diverticle each.
5. No gizzard. No penial setæ. Sperm-ducts join the prostates in the body-wall.
Microscolex algeriensis BEDDARD (38).
6. Gizzard rudimentary. Penial setæ present. Sperm-ducts open on segment behind the prostates.
Microscolex phosphoreus (DUGÈS) MICHAELSEN (30).
7. Gizzard rudimentary. Setæ convergent. Penial setæ smooth, with end knob. Sperm-ducts open into the prostates.
Microscolex Horstii, sp. nov.

III. Two pairs of testes. Spermathecæ present, with two diverticles each.
8. No gizzard. Distance *a–b* several times smaller than *c–d*.
Microscolex Benhami (EISEN, 16).
9. No gizzard. Distance *a–b* about equal to *c–d*.
Microscolex Troyeri (EISEN, 16).
10. Gizzard rudimentary, in V. Setæ not converging. All nephropores in front of setæ *c*. Prostates and sperm-ducts open together in the same pore.
Microscolex novæ-zelandiæ BEDDARD (25).
11. Gizzard rudimentary, in V. Setæ converging. Sperm-ducts open into the muscular prostate. Nephropores II–IV in front of setæ *d*.....*Microscolex parvus*, sp. nov.
12. Gizzard rudimentary, in V. Setæ converging. Nephropores II–IV in front of setæ *d*. Prostates and sperm-ducts open in separate pores.
Microscolex Hempeli SMITH (3).
13. Gizzard in VIII. Sperm-sacs in XII. Prostomium complete.....*Microscolex monticola* BEDDARD (86).

B. One pair of testes.

Yagansia *Michaelsen* (30).

I. Spermatheca with one diverticle each.
1. Gizzard in V. Prostomium incomplete. Setæ paired; penial setæ long. No dorsal pores. Spermathecæ in IX. Sperm-sacs in IX and XI. Prostates extend back many somites..... *Yagansia papillosa* (BEDDARD, 87).
2. Gizzard in VI. Prostomium incomplete. Setæ paired. Penial setæ long. Dorsal pores present. Spermathecæ in IX. Sperm-sacs in XI.
Yagansia longiseta (BEDDARD, 87).
3. Gizzard in VI. Prostomium complete. Setæ paired; penial setæ curved, without exterior sculpture. Sperm-sacs in XI.
Yagansia pallida MICHAELSEN (28).

4. Gizzard in VI. Setæ paired; penial setæ with crenate ridges. Sperm-sacs in XI.

Yagansia spatulifer MICHAELSEN (13).

5. Gizzard in VI. Prostomium complete. Setæ paired; penial setæ with spinelets. Sperm-sacs in IX and XI. Spermathecal diverticle forked.

Yagansia grisea (BEDDARD, 87).

6. Gizzards in VI and VII. Prostomium complete. Setæ separated; penial setæ smooth. Dorsal pores present. Sperm-sacs in IX and XI. Sperm-ducts open separately from the prostates.

Yagansia diversicolor (BEDDARD, 87).

7. Gizzards in VI and VII. Prostomium complete. Setæ paired; penial setæ with transverse ridges, flattened and wider at apex. Dorsal pores present. Sperm-sacs in XI.

Yagansia corralensis (BEDDARD, 87).

8. Gizzard in VII. Prostomium complete. Setæ separated; penial setæ smooth. No dorsal pores. Sperm-sacs in XI.

Yagansia robusta (BEDDARD, 87).

9. Gizzard in VIII. Prostomium complete. Setæ separated; penial setæ smooth. No dorsal pores. Sperm-sacs in XI and XII.

Yagansia gracilis (BEDDARD, 87).

II. Spermathecæ with two diverticles each.

10. Gizzards rudimentary. Sperm-ducts open behind the prostates in a groove. Penial setæ with spinelets.

Yagansia Michaelseni (BEDDARD, 87).

C. Two pairs of testes; four pairs of spermathecæ, in VI–IX.

Rhododrilus *Beddard.*

Rhododrilus minutus BEDDARD (37).

Microscolex *Rosa.*

Microscolex elegans *(Eisen).*

Deltania elegans EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 5, 1896.

The following additional characteristics not mentioned in the former description are of considerable interest:—

Gizzard.—There is a small rudimentary gizzard in somite V. The transverse muscular layer is increased some three or four times, but still is not sufficiently thick to form a perfect gizzard. The intestine widens but little in this somite and cannot be seen well except in sections.

Spermathecæ.—There are no real spermathecæ and the peculiar sacs filled with spermatozoa found in the specimens first described are of doubtful character; they do not open exteriorly. Similar structures have not been found in any specimens dissected or sectioned recently.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—This species was found to be common in southern California where I have collected it on Santa Rosa Island and at Santa Barbara. On the island it appears to be the most common species and there can be no doubt but that it is indigenous.

M. elegans is represented in the eastern United States by *M. carolinæ*, the main difference between the two being the manner in which the sperm-ducts join the prostates. In *M. elegans* the junction is in the body-wall, while in *M. carolinæ* the sperm-ducts join the prostate half-way between the body-wall and the glandular part. The former species is much more delicate than the latter, which may be readily transported long distances without injury.

Microscolex carolinæ, sp. nov.

Definition.—Length 90–110 mm., width below clitellum 4 mm. Prostomium incomplete. Dorsal pores posterior to clitellum. Clitellum perfect, XIII-XVII. Setæ rather distant; those in the ventral couples and posterior to clitellum converging towards the male pores, but those in front of the clitellum not converging. Oviducal pores in line with setæ *a*. Spermiducal pores in XVII. Penial setæ present. Testes in X and XI. Sperm-sacs small and very racemose in XI, XII. Rudimentary gizzard in V. No spermathecæ. Sacculated intestine in XVII. Nephridia without sphincter. Color flesh with a brick red clitellum.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—The specimens were collected in the uplands near Raleigh, North Carolina, by Messrs. Brimley.

This species is more robust and of a deeper color than *M. elegans*. The principal differences appear to be the following: The sperm-ducts join the muscular part of the prostate half-way between the body-wall and the glandular part. The nephridia do not seem to possess the sphincter, and the sperm-sacs are much more racemose and the lobes narrower than in *M. elegans*.

DETAILED DESCRIPTION.

Somites.—The somites anterior to the clitellum are of about the same width.

Setæ.—Only those setæ anterior to the male pores converge towards these pores. The setæ are distant as follows:—Interval *a–a=b–c*, but is slightly narrower than *c–d*; *a–b* is about two-thirds that of *a–a*. Setæ *c* and *d* are slightly dorsal. The penial setæ are not unusually long. They are of medium size; the apex is almost straight, ornamented with about twelve rows of faint, short, transverse, wavey depressions or lines, of which there are about three abreast, running somewhat diagonally in the direction of the short diameter.

Intestine.—The gizzard is rather imperfectly developed and very small. It is hardly wider than the balance of the intestine, is principally developed inwardly and does not cause the intestine to bulge out. It is entirely confined to somite V. The somites following are strongly nipped by the septa. The sacculated intestine, commencing in XVII, possesses very thin walls. No large chloragogen cells are found on any of the divisions of the intestine.

The *septa* are all very narrow and those slightly thickened are not more than twice as thick as the others. All the anterior septa are attached half-way between the grooves.

Glands.—The suprapharyngeal glands are well developed and show a succession of lobes increasing in size posteriorly. The septal glands are very minute and are found in somites V, VI, VII, VIII and IX; in the latter somite they are entirely ventral and exceedingly small, as seen in longitudinal sections of the body.

Sexual Organs.—The testes are found in somites X and XI, the spermiducal funnels in the same somite, while the sperm-sacs are in XI and XII. The latter are small, strongly racemose and entirely confined to the ventral part of the body, not rising above the intestine. The ovaries are as usual in XIII. They are strongly fringed, the individual strands not being more than one ovum thick.

The sperm-ducts are separate to the very point where they enter the prostate glands. The prostates are confined to one somite. They are very nearly straight, with the top slightly bent over. They consist of two distinct parts, of which the lower is narrower and strongly muscular. The larger, glandular part is club-shaped, the inner or distal part being the thickest. The sperm-ducts enter the muscular part at a point situated half-way between the body-wall and the glandular part of the prostate. The glandular cells are not arranged in two distinct layers; there are, however, two kinds of glandular cells. The inner layer, consisting of the narrowest cells, projects everywhere into the outer layer, making the boundary between the two layers very indistinct.

The *nephridia* commence in somite II, but the body of the first nephridium is situated mainly in III. Each nephridium is furnished with a large terminal vesicle which opens directly through the body-wall. There is no urinary bladder, nor is the exterior pore furnished with large sphincter cells, as in *Microscolex elegans* (Eisen 16). At the point in the clitellum where the vesicle opens into the pore, the clitellar cells suddenly narrow down, thus allowing the vesicle to connect directly with the pore. The nephropores are slightly ventral and anterior to setæ *c*.

Microscolex parvus, sp. nov.

PLATE XIV, FIGS. 183, 184.

Definition.—Length 35-45 mm., width 1-1½ mm. Somites 85. Prostomium does not encroach on somite I. The ventral part of somite I is half as wide as its dorsal part; the somite is narrower than somite II. Dorsal pores begin about VIII-IX, a very large one between XIII/XIV. Setæ posterior as well as anterior to the male pore converging towards that pore. Penial setæ sigmoid at apex. Spermiducal pores in XVII. Oviducal pores separate, in line with setæ I. Spermathecal pores in line with setæ I, in VIII/IX. Spermatheca with two diverticles. Testes, two pairs in X and XI. Sperm-sacs small, racemose, in XI and XII. A small ovisac in XIV. Gizzard very rudimentary. Sacculated intestine commences in XVI. Sperm-ducts open into the prostate. Muscular part of the prostate half as long again as the glandular part. Color very pale flesh with pale, yellowish clitellum.

Habitat.—Santa Rosa Island, and Santa Barbara, California. The writer collected some ten or fifteen specimens in moist garden soil in May and June. I have no hesitation in pronouncing this species indigenous to California. Its geographical distribution eastward is probably quite extensive.

Outwardly this species resembles *M. Troyeri*, but differs in the size of somite I and in having ventral papillæ and a rudimentary gizzard. It differs from *M. Hempeli* in having the sperm-ducts open into the prostate; while the deltoid arrangement of the ventral setæ is different from that of *M. novæ-zælandiæ*.

DETAILED DESCRIPTION.

Somites.—The somites in front of the clitellum are of about the same size, excepting somite I, which is smaller, its ventral part being only one-half as wide as the dorsal part. Somite X is slightly smaller than somites IX and XI.

Papillæ.—A pair of papillæ surrounds setæ *a* in somite XI, and a single median papilla which, however, is sometimes missing, is found in XII.

Setæ.—The deltoid arrangement of the setæ is found both anterior and posterior to the male pores. This arrangement of the setæ in *M. parvus* resembles that in *M. Troyeri*, except that the anterior ventral setæ are closer together in the latter species, although not so close as in *M. Benhami*. If we assume that in somite IX the interval between the setæ *a* is equivalent to 11, we get the following ratios:—

Somite IX: a–a=11, a–b=8, b–c=15, c–d=14.
Somite XIV: a–a=14, a–b=7; setæ c, d missing.
Somite XVIII: a–a=17, a–b=4, b–c=35; setæ d missing.
Somite XXV: a–a=20, a–b=15, b–c=30, c–d=18.
Somite XXXIV: a–a=20, a–b=17, b–c=30, c–d=18.

The deltoid arrangement begins posteriorly with somite XIII, or thereabout, and ends with somite XVIII. In somite XVIII the distance between setæ *a* and *b* is only

half that between the corresponding setæ in somite IX. Setæ *c* and *d* are as a rule absent in the clitellum. The common setæ are faintly ornamented with six or eight rows of short transverse wavey lines running obliquely across the seta from apex to center.

Penial Setæ.—The penial setæ are slightly sigmoid at the very apex. The one I dissected was smooth except for two or three deep creases in the concave part just below the apex, but I am not certain whether these creases were natural or accidental.

Septa.—The septa are all narrow and those thickened are only slightly so.

Intestine.—The *pharynx* is developed only dorsally; it forms a deep fold or sinus.

The *gizzard* in V is very rudimentary, the thickened muscular layer being not more than twice as thick as the same muscular layer in the following somites. It does not cause the least swelling of the intestine in somite V, and is hardly noticeable. The tubular part of the intestine is very straight and only slightly nipped by the septa. This part of the intestine is ciliated in somite XVI and in the posterior part of XV. In XVI it connects with the sacculated intestine which begins in XVI. The intestine is covered with small chloragogen cells in XV to XXIV.

Sexual Organs.—These offer few characteristics. There are two pairs of testes, two pairs of sperm-sacs, and one pair of short ovisacs in XIV, projecting from the anterior septum backwards.

The *sperm-ducts* run singly until they join the prostate at a point just before it enters the body-wall; therefore the ducts actually enter the prostate. The prostate consists of a glandular and a muscular part, the former being from three to four times as wide as the latter, which equals it in length, or may be even longer. In one specimen the muscular part is half as long again as the glandular; in another they are of about the same length. The glandular part consists of

two layers of cells, but the inner layer is made up of very narrow cells. The glandular part is slightly folded and is confined to somites XVIII and XIX, or to XVIII alone. The spermathecæ consist of one pair of sac-like bodies of oblong shape and irregular outline. The two diverticles are of unequal size. They are about one-third the length of the spermatheca. The nephridia commence in somite II. The four most anterior pores are in line with setæ *d*, those following are in a line with setæ *c*, slightly ventral to them. The nephropores in the clitellar somites are much larger and more transparent than the others; they are surrounded by a ring of very large cells.

Microscolex parvus, var. **carolinianus**, var. nov.

Definition.—Length 45 mm., width 2 mm. Clitellum ½ XIII-½ XVII. Papillæ: two on the ventral surface of XI and one median and ventral in XII; also a single ventral, median one on the boundary between XVII and XVIII, posterior to the male pores. Setæ deltoid in their position towards the male pore, the same as in the species. Dorsal pore between III and IV but the first plain one between VII and VIII. A very large dorsal pore between XIII and XIV. Spermathecæ larger than in the species and the diverticles almost as long as the main sac. The muscular part of the prostate is somewhat smaller than the glandular part. The gizzard is less rudimentary, the muscular layer being about three to four times larger than the corresponding layer in somite VI. The septal glands in somites V to IX are less developed than in the species.

Habitat.—Raleigh, North Carolina. Two specimens collected by Messrs. Brimley.

As is seen, the variety differs from the species only in the greater development of various interior organs. The principal difference is in the spermathecæ with their large diverticles, those of the species being particularly small. Intermediate forms with the species will no doubt be found.

Microscolex Troyeri *(Eisen).*

Deltania Troyeri EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 3, 1894.

This species is widely distributed. Specimens are represented from the following localities: Coulterville, Calif., twelve miles east of the town in the region of the yellow

pine in the Sierra Nevada mountains; Redding, Calif., collected by Mr. Richard C. McGregor; San Francisco, Calif., collected from flower pots by Mr. Charles Fuchs; Orizaba, Mexico, collected by Mr. Albert Koebele.

The species resembles *M. parvus* in the arrangement of the setæ, but differs externally, somite I being broader. In *M. parvus* somite I is much narrower on the ventral side than on the dorsal, and the whole somite is much narrower than somite II. In *M. Troyeri* somite I is wider than somite II, and is not narrower on the ventral side. *M. Troyeri* possesses no ventral papillæ on any of the somites.

Microscolex Horsti, sp. nov.

PLATE XIV, FIG. 185.

Definition.—Length 20 mm., width 1½ mm. Somites 45. Setæ, beginning with XXI, deltoid in arrangement both posterior and anterior to the male pore. Small ventral paired tubercles in XI; two large ventral tubercles in XIV adjoining and dorsal to the ovipores, which are in line with setæ *a*. The male pores are so close together that they appear to be situated on the same papilla, between setæ *a*, in XVII. Somite I is narrower than II, and its dorsal side is half as wide as the ventral. Somites I–VI.are a third narrower than those following. Clitellum perfect in XIII–XVII. Penial setæ unequal, the longer curved, the shorter straight; both with the apex knob-like and smooth. Testes in X and XI. Sperm-sacs small, racemose, in XI and XII. Sperm-ducts open into the muscular prostate. Prostate thick and bent, confined to one somite. Spermathecæ, one pair in IX, each with one diverticle. A small rudimentary gizzard in V.

Habitat.—One specimen found among roots of plants in a flower pot brought from Honolulu, Hawaii. Taken in April, 1898, by Mr. Alexander Craw, State Horticultural Quarantine Officer of California.

This species is well characterized. The close proximity of the male pores, the single diverticle of the spermathecæ, the rudimentary gizzard, and the knob-like apex of the penial setæ serve to place it in the group formed by *Microscolex algeriensis* and *Microscolex modestus*.

Unfortunately the specimen is badly twisted and all the points could not be determined, but enough was shown to entirely separate it from the two nearest allied species.

The most anterior *nephridia* are probably in II, beyond doubt in III. The *intestine* which is unusually narrow, is nipped by the septa, and the *gizzard* is very rudimentary; its muscular layer is of about the same thickness as the muscular layer of the body-wall—not thick enough to cause the intestine to bulge out. The sacculated intestine commences in somite XVI. The *pharynx* also is developed ventrally and furnished with subpharyngeal glands. Strong *septal glands* extend back to somite VIII, there being none in somite IX. The *spermathecæ* are strong, each with a single, rather large diverticle pointed backwards. The diverticle joins the muscular part of the spermatheca close to the body-wall. The *sperm-ducts* join the muscular part of the *prostate* in the body-wall. Septa VIII to XIV are somewhat thickened. The *septa* on all the anterior somites are attached to the body-wall half way between the intersegmental grooves, in line with the setæ. The interval between setæ *a* and *b* is slightly less than that between *c* and *d*. In a general way the arrangement of the setæ resembles that of *M. Troyeri*.

PLUTELLINÆ.

NOMENCLATURE.

In his Monograph on Oligochæta Beddard refers all the species of *Plutellus* and *Argilophilus* to the genus *Megascolides*. The genus *Plutellus* was created for a worm with alternating nephropores, meganephridia, five pairs of spermathecæ and with calciferous diverticles in X, XI, XII. The genus *Megascolides* was established by McCoy for a worm with plectonephridia, two pairs of spermathecæ, one diverticle of the intestine, etc. My genus *Argilophilus* was made for species with meganephridia, two pairs of spermathecæ, no calciferous diverticles, alternating nephropores. If the various species are to be bunched under one genus, then there can be no doubt but that the genus *Plutellus* must be retained. But I think that we are not yet ready to join plectonephric species with meganephric ones in one genus.

There are other reasons why I do not think that *Plutellus* and *Argilophilus* are generically connected. Benham's species *Plutellus Perrieri* possesses only one pair of testes and one pair of sperm-funnels, and the funnels are enclosed with the testes in a special sac. Scrutinizing Perrier's description of his *Plutellus heteroporus*, it seems to me probable that his species agrees with Benham's in some very important points. May not Perrier have mistaken the sperm-funnel for oviduct and the testes in X for ovaries? If such is the case, his species would resemble Benham's in having one pair of testes and one pair of funnels, which character I think will be sufficient to relegate the two species to separate genera. In the only other American species, *Megascolides americanus* Smith, related to these species of Benham and Perrier we find plectonephridia and two pairs of spermathecæ. This species is thus undoubtedly more related to the Australian species than to the American ones, and I think Professor Smith is right in referring it to *Megascolides*. It possesses plectonephridia and two pairs of testes and sperm-funnels. As for *Argilophilus*, I propose the genus for species with two pairs of testes and funnels and with meganephridia.

AMERICAN SPECIES OF *Plutellinæ*.

A. Meganephridia, one pair of testes and one pair of sperm-funnels, more than two pairs (four or five) of spermathecæ.

Plutellus *Perrier*.

1. Three pairs calciferous glands.

Plutellus heteroporus PERRIER.

2. No calciferous glands.

Plutellus Perrieri BENHAM.

B. Meganephridia, two pairs of testes and two pairs of sperm-funnels, no calciferous diverticles.

Argilophilus *Eisen*.

Argilophilus marmoratus EISEN.
Argilophilus hyalinus, sp. nov.

C. Plectonephridia, two pairs of testes and two pairs of funnels, no distinct calciferous diverticles.

Megascolides *McCoy*.

Megascolides americanus SMITH.

A revision of the species belonging to the above genera is highly desirable, but until it is done nothing is gained by lumping together the species under one genus.

Argilophilus *Eisen.*

Argilophilus hyalinus, sp. nov.

Definition.—Length of contracted specimen 90 mm., width 4 mm. Setæ paired. Penial setæ present. Clitellum saddle-shaped, in XIII–XIX. Gizzard in V, very large. Spermathecæ three pairs, without diverticles, in VII, VIII, IX. Spermathecal pores are postseptal, in front of setæ *b*. Testes in X, XI. Sperm-funnels in X, XI. Ovaries in XIII. Oviducts in XIV, opening in front of setæ *a*. Sperm-ducts join in XVIII. One pair of tubular, coiled prostates in XVIII. The intestine without diverticles. Nephridia are meganephric. Color hyaline, without any pigment.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII.

Habitat.—Coban, Guatemala, Central America. A single specimen.

To the above short definition I can add only a very few details on account of the maceration of the single specimen. The definition is, however, sufficient, as the three pairs of spermathecæ without diverticles serve to fully characterize the species. The form of the *spermatheca* is that of an unopened toadstool. In size the spermathecæ are small, not reaching much above half the diameter of the worm. The *prostate* is flattened and coiled in one plane, spreading over two or three somites. The muscular part is thickest near the base. The *sperm-ducts* probably enter the prostate at the junction of the glandular and muscular parts. The *setæ* are almost smooth except for a few small notches on the inner side near the apex. The penial setæ are of medium size, slightly curved, with some shallow corrugations along the free end.

Argilophilus marmoratus collinus, subsp. nov.

PLATE XII, FIGS. 118–121.

Definition.—Male pores situated on lunate papillæ, which are somewhat sunk and entirely enclosed by a continuous oval ridge. The two ridges are connected by a median elevated band running in the direction of the long

diameter of the body. Puberty-papillæ varying in number, single, median, never paired. The ventral interval between setæ *a*–*a* slightly diminishing from about somite XXIV to somite XVII. Penial setæ with a few large spines near apex. No dorsal pores. Prostomium divides somite I from one-half to nine-tenths, and is furnished with two cross grooves.

Habitat.—California: Calistoga, Napa County; Mill Valley, Marin County; also at Duncan Mills, Sonoma County; on rather dry hill sides among manzanita bushes and other native vegetation. My attention was first called to this interesting form by Dr. H. W. Harkness, to whom my thanks are due for many fine specimens.

AFFINITIES AND CHARACTERISTICS.

Although this worm differs considerably from the other Californian forms of the genus I do not consider it to be an independent, well defined species—no more so than *A. ornatus* and *A. papillifer*. These three forms are only externally distinct, and so far as I can see agree in internal structure. They appear to me as the beginning of species branching from a common stock. With these exterior differences are connected differences in habitat. *A. papillifer* is only found in comparatively very moist places, generally in heavy adobe soil, such as near streams, along ditches, under logs, in flooded places. *A. ornatus* is found in less moist places, in ordinary adobe soil, while *A. collinus* is found only on dry hill sides, which are never exposed to excessive moisture. I have nowhere found these forms intermingling with each other in the same locality, and it appears as if their external structure was due, in part at least, to their different habitats.

A. papillifer resembles *A. collinus* in possessing only unpaired median puberty papillæ, while *A. ornatus* possesses pairs of such papillæ in the intersegmental grooves. In *A. ornatus* and *A. papillifer* the structure of the genital zone is the same, the male papillæ being connected by a thin transverse band, running in the short diameter of the body.

In *A. collinus* this band is broad and runs in the long diameter of the body. In *A. ornatus* and *A. papillifer* the ventral interval between setæ *a–a* does not narrow towards the male pore, while in *A. collinus* this distance becomes less towards the male pore. There is also a slight divergence between the setæ *a–a* anterior of the male pore (fig. 119).

Another slight difference is seen in the prostomium. In *A. collinus* the prostomium divides somite I very deeply, sometimes almost entirely, while in *A. papillifer* and *A. ornatus* the posterior prolongation of the prostomium never exceeds the middle of somite I.

As the triple nomenclature has been objected to by some, it may be advisable to retain the name *A. marmoratus* for the form without papillæ, making those with papillæ varieties under this species.

DIPLOCARDINÆ.

General Remarks on Affinity.

Michaelsen's (30) suggestion that the genus *Diplocardia* be referred to a family of its own is, I think, a good one. But I do not agree with him in regard to the distinguishing feature of the family. The genus *Trigaster* and my new genus *Zapotecia* are the disturbing factors in a perfectly satisfactory arrangement of the genera and species of this family and those of *Benhaminæ*. The question arises, which character should be given more weight, the nephridia or the calciferous diverticles? Whichever is adopted, we meet with difficulties. On the whole, I think that in this instance the calciferous diverticles are of more systematic importance than the nephridia. Accordingly, I place in this family the genera *Trigaster* and *Zapotecia*. The latter genus is created for a species with meganephridia and without calciferous diverticles. To join this species with *Diplocardia* is, according to present ideas, impossible,

and I think it is best to keep species with three gizzards out of that genus. The completely hidden nature of the sperm-ducts is also an interesting feature of the genus, which character it shares with *Trigaster*. To join *Zapotecia* with *Benhamia* is even less natural. With the genus *Trigaster* there is a greater affinity and at first I had arranged the species under that genus; but it now seems to me more proper to keep meganephric and plectonephric species apart, except in cases where we know with certainty that great variation exists in their structure, as for instance, in *Dichogaster*.

In a preliminary paper (Eisen 22) have been noted in a general way the characteristics of various species of *Diplocardia* which have been examined critically. Through the kindness of Professor Frank Smith of the State Biological Laboratory of Champaign, Illinois, I have been enabled to study the specimens of all the *Diplocardia* species in his possession, and have made observations on some points which previously had been either overlooked or misunderstood.

Professor Smith has also had the kindness to call my attention to a couple of errors in the above mentioned paper. The species of *Diplocardia* so far known are remarkably well characterized for identification, differing strikingly in the external genital zones as well as in their inner organization. The median ventral zone around the prostates is well marked, but I think too much significance should not be placed on the presence or absence of papillæ, there being considerable variation in different specimens. Of more importance is the form and size of the zone, the curvature and shape of the sexual grooves between the prostates, the size and ornamentation of the penial and spermathecal setæ, the location of the spermathecal pores, etc.

By courtesy of Professor Albert Koebele I add the description of a new species, characterized by the position of the male pores in somite XVIII. This raises the

number of known species of *Diplocardia* to nine, which is probably but a small fraction of what will be found in the future.

MORPHOLOGICAL FEATURES.

There are several structural details in the finer anatomy of *Diplocardia* which are of more than common interest, for example, the glandular crop in somites XIV and XV, which is found in at least one of the species, *Diplocardia Michaelseni*, and which may exist in others. In another species, *Diplocardia Eiseni*, Michaelsen found lime-secreting tissues in the same somites. This structure is said by him to resemble that of the calciferous diverticles without partaking of the diverticular nature.

Another interesting morphological feature of this genus is the structure of the prostate. I have investigated the prostates of *D. singularis caroliniana*, *D. Udei* and *D. Michaelseni*. In all these species the prostates are exteriorly more or less tubular, but the surface is rough, warty, wavey and uneven. Longitudinal sections show the lumen of the glandular part in *D. caroliniana* to be rather wide and straight, continuing regular from one end to the other. It is lined by large columnar epithelial cells as is usual in all higher terrestrial Oligochæta except the Ocnerodrilini.

In the glandular prostate of *D. Michaelseni* the lumen is very narrow, being no wider than the lumen of the muscular part; and instead of being unbroken it sends out along its entire course numerous large or small side branches into which open the glandular prostate cells, though some also open in the main canal. The main lumen, as well as the branches, is lined by what appears to be a membrane consisting of thin, narrow strands of connective tissue, in which no nuclei are seen. In other words, the inner epethelial layer of cells, which is supposed to be characteristic of the higher Terricolæ, is wanting.

In *D. Udei* the main lumen of the glandular prostate is so irregular and branching that none of the sections show

more than a very short piece of it. Everywhere in the mass were seen numerous minute lumens, so small that they could barely be studied with the highest lens systems. The lumen system in this species is racemose, very similar to the stem of a bunch of grapes. The main lumen and the branches are lined by narrow strands, the same as in *D. Michaelseni*. In addition to these, the main lumen has here and there minute epithelial cells; these, however, are absent in the branches. Thus, *D. Udei* takes an intermediate position between the two other species mentioned above. The variations in the position of the spermiducal pores, ranging from XVIII to XXI, are also of the greatest interest. It seems probable that when more species are known, the genus *Diplocardia* will prove to be of great morphological interest.

Diplocardia *Garman*.

Definition.—Setæ, eight, in four couples, lateral and ventral. Penial setæ, present or absent. Spermathecal setæ, present or absent. Prostomium divides somite I more or less. Clitellum saddle- or ring-like, generally XIII-XVIII. Oviducal pores XIV. Spermathecal pores, two or three pairs, either postseptal or preseptal. Spermiducal pores on XVIII, XIX, XX, or XXI, according to species. Prostate pores on somites next anterior and posterior to the spermiducal pores. The pores on each side connected by a groove. A genital zone generally present, with or without papillæ. Intestine with two gizzards, generally in V, VI. Œsophagus either with or without folds containing calcic concretions. Tubular intestine never with calciferous diverticles, as in *Benhamia*. A glandular crop sometimes in XIV and XV. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Two pairs testes in X and XI. Two pairs sperm-funnels in X and XI. Prostates, two pairs opening anteriorly and posteriorly to the sperm-ducts. Spermathecæ, two or three pairs, each one with a diverticle near the center. Dorsal vessel double or single. Nephridia and meganephridia generally without cœlomic mantle.

Habitat.—As far as known, the genus is confined to the United States and to northern Mexico.

The following subdivision of *Diplocardia* is based on the location of the spermiducal pores:—

KEY TO THE SUBGENERA AND SPECIES OF *Diplocardia*.

I. Spermiducal pores in somite XXI. No penial setæ.

Aleodrilus EISEN.

1. *Keyesi* (EISEN).

II. Spermiducal pores in somite XX.

Omahania, subgen. nov.

2. *verrucosa* UDE.

III. Spermiducal pores in XIX.

Diplocardia GARMAN (sens. str.).

a. Spermathecæ two pairs.

3. Both pairs of spermathecal pores are posterior to setæ or preseptal; sexual spermathecal setæ in VIII and IX.
Eiseni (MICHAELSEN).

4. The pair of spermathecal pores in VIII is postseptal; the pair in IX is preseptal; sexual spermathecal setæ in VIII and IX.
Michaelseni EISEN.

5. Both pairs of spermathecal pores are postseptal; sexual spermathecal setæ in VIII, IX and X..... *Udei* EISEN.

6. Both pairs of spermathecal pores are postseptal; no sexual spermathecal setæ..... *riparia* SMITH.

b. Spermathecæ three pairs.

7. Penial setæ straight, about one-half longer than ordinary setæ. Sperm-ducts are hidden in the body-wall.
communis GARMAN.

8. Penial setæ sigmoid, several times longer than ordinary setæ.

a. Penial setæ not ornamented. Color dark brown.
singularis (UDE).

b. Penial setæ ornamented. Color pink.
singularis caroliniana, subsp. nov.

IV. Spermiducal pores in XVIII.

Naillenia, subgen. nov.

9. Spermathecæ two pairs. Their pores postseptal, in VIII and IX. Sexual spermathecal setæ in IX.
Koebeli, sp. nov.

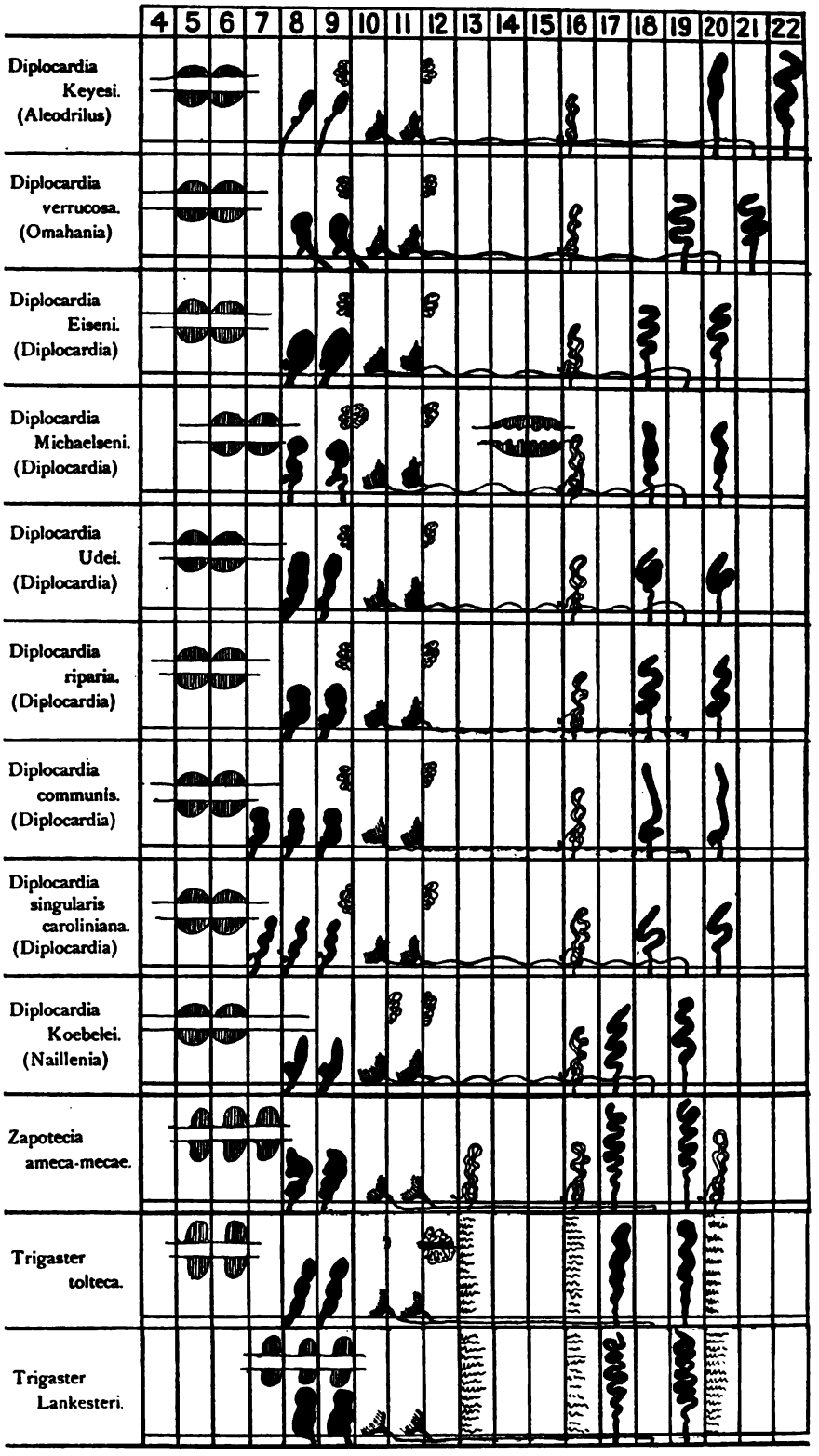


DIAGRAM SHOWING LOCATION OF GIZZARDS, SPERMATHECÆ, SPERM-SACS, SPERM-DUCTS, PROSTATES AND THE NATURE OF THE NEPHRIDIA.

Diplocardia (Aleodrilus) Keyesi *(Eisen).*

PLATE XIII, FIG. 136.

Aleodrilus Keyesi EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 5, 1896.
Diplocardia Keyesi EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, flesh, marbled violet, no pigment. Size, 70 mm. by 5 mm. Somites, 150. Prostomium divides somite I about one-half. Dorsal pores, the most anterior one in I, VIII/IX. Spermiducal pores in XXI. Spermathecal pores, two pairs, in VIII and IX, in front of setæ *ab*. Prostate pores in XX and XXII. Oviducal pores in front of setæ *a*. Setæ all ventral; *a–b* slightly larger than *c–d*; *a–a* larger than *b–c*. No sculpture. Penial setæ none. Spermathecal setæ not differentiated. Clitellum ring-like anteriorly, posteriorly saddle-shaped. Genital zone not distinct; two parallel grooves in ½ XX-½ XXII; groove almost straight, with a knob at each apex; concavity turned ventrally. Œsophagus without calcic concretions. Gizzards in V and VI. Sacculated intestine in XV. Dorsal vessel single, not covered with chloragogen cells. Hearts in X, XI, XII, with large pulsating divisions; no chloragogen cells. Nephridia, meganephridia, no cœlomic mantle. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts, which join at XII/XIII in a common muscular sheath; fuse in XX/XXI. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Sperm-masses in X and XI. Oviducts in XIV. Prostates confined to one somite each, small, tubular, thicker at apex. Spermathecæ, two pairs in VIII and IX; distal end knob-like; the duct is very slender and long, with a minute wart-like and ear-shaped diverticle situated about the middle.

Septal formula:—

$$\overline{\text{VI/VII}},\ \overline{\overline{\text{VII/VIII}}},\ \overline{\overline{\text{VIII/IX}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\text{X/XI}}.$$

Habitat.—Ensenada de Todos Santos, Baja California, Mexico.

DETAILED DESCRIPTION.

Spermathecæ.—(fig. 136). The form of the spermathecæ is the same as was figured in a previous paper (Eisen 18). The duct is very long and slender, though confined to one somite. It carries a small wart-like and ear-shaped diverticle, situated about half-way from the globular knob to the base. In this respect the species agrees with the other known species of the genus. The diverticle is no wider than the duct and resembles an agglomeration of three or four minute warty protuberances. In the former paper these protuberances were noted but were then considered accidental. I am now satisfied that they constitute a true

though minute spermathecal diverticle, being constant both in position and size, as I afterwards ascertained by examination of another specimen.

Sperm-sacs.—There are two pairs of sperm-sacs. One pair is preseptal and slightly racemose in IX, protruding into the somite from septum IX/X. It is situated laterally and rather ventrally. A pair of strongly racemose sperm-sacs is also found in XII, but these are postseptal, protruding backward into XII from septum XI/XII. These latter sperm-sacs are much larger and much more racemose than those in IX. Hence it will be seen that *D. Keyesi* even in this respect agrees with the other species of the genus.

Subgenus **Omahania**, subgen. nov.

Diplocardia (Omahania) verrucosa (*Ude*).

Diplocardia verrucosa UDE, Zeitschr. wiss. Zool. Bd. LXI, 1895, p. 133; EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, pink. Size, 65 to 75 mm. by 2.5 to 3 mm. Somites, 100 to 125, body round, of even thickness. Prostomium divides somite I by one-half. Dorsal pores, most anterior one VIII/IX (or X/XI). Spermiducal pores on XX. Spermathecal pores on anterior third of somites IX and X, somewhat dorsal to setæ *d*. Prostate pores on XIX and XXI. Oviducal pores interior to setæ *a*; no glandular ridge. Setæ sigmoid, very faintly ornamented. Distance *d*–*d* more than half the periphery; *c*–*d* somewhat greater than *a*–*b*; *a*–*a* three times, and *b*–*b* two and a half times greater than *a*–*b*, no setæ *ab* in XX. Penial setæ curved, not ornamented. Spermathecal setæ not differentiated. Clitellum saddle-shaped, XIII–XVIII. Genital zone a rectangular field from posterior ⅓ XVIII–½ XXII, extending laterally to center between *b*–*c*. Two deep grooves from ½ XIX–½ XXI, the convexity of which is outwards, except in the center of XX, where it is turned towards the median line; one median papillæ on XXII; one pair papillæ on XIX in line with setæ *b*; one pair papillæ on XIX and XXI, interior to grooves; one pair papillæ exterior to grooves on each of XIX, XXI, XXII (two pairs papillæ on each of XIX, XXI, and three papillæ on XXII). Œsophagus, no calciferous folds or thickenings. Gizzards in V and VI. Sacculated intestine commences in XVI. Dorsal vessel single. Hearts, three pairs in X, XI, XII. Nephridia, meganephridia, commence in II, pores intersegmental in front of setæ *d*. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts open in central part of groove in XX. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Oviducts open in front of and interior to setæ *a*. Prostates very thin, even, bent in four folds, confined to one somite each.

Spermathecæ, two pairs in VIII and IX, retort-like, with a small, short-stalked, ear-like diverticle below the center. No specialized spermathecal setæ.

Septal formula:—

VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII.

Habitat.—Omaha, Nebraska.

The above definition is taken from Ude's description. There is in my mind some doubt about the position of the spermathecal pores in *Diplocardia verrucosa*. Ude says that the pores are situated on the anterior third of IX and X, and between the setæ *d*. In specimens sent me by Dr. Frank Smith labeled *D. verrucosa*, the spermathecal pores are situated in IX and X, as described by Ude, but the pores are a little dorsal to setæ *a*. However, we must for the present accept Ude's statement, twice repeated (pp. 133 and 135), and will therefore assume that the specimen sent by Dr. Smith belongs to a different species, also belonging to the subgenus *Omahania*. What throws a doubt on the position of the spermathecal pores is the fact that Ude (5, p. 135) states that the ovipores also open between setæ *d*. His fig. 14, however, shows that these pores open normally, that is, ventral to setæ *a*. The references to setæ *d* may be a misprint in both instances. *D. verrucosa*, as well as the species sent me by Dr. Smith, differs also from all of the *Diplocardias* in the position of the spermathecal pores in IX and X. In no other species is a spermathecal pore found in X. This may possibly be a characteristic of the subgenus *Omahania*.

Subgenus **Diplocardia** *Garman*.

Diplocardia Eiseni *(Michaelsen)*.

Geodrilus Eiseni MICHAELSEN, Zool. Jahr., Abth. Syst. Bd. VIII, 1894, p. 177.
Diplocardia Eiseni (MICHAELSEN) EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, dorsally dark brown, pigmented, clitellum violet gray. Size, 150 mm. by 2 mm. Somites 165; VIII–XIII smoother and wider than the others. Prostomium divides somite I about one-half, with the lateral margins strongly converging. Dorsal pores, most anterior one on XI, first

distinct one on XIII. Spermiducal pores on XIX in line with setæ *a*. Spermathecal pores on VIII and IX, posterior to setæ *a*, in line with *a–b*. Prostate pores on XVIII and XX, in line with setæ *b*. Oviducal pores near median line, surrounded by a zone. Setæ, sigmoid, with numerous fine bars; *a–a* about one-twelfth, *d–d*, five-ninths the whole periphery; *b–c* is shorter than *a–a*; *ab* shorter than *c–d; a–b*, half as long as *b–c; ab*, slightly shorter than *c–d*. Setæ *b* in XIX is present, *a* is absent or present. Penial setæ rudimentary or very small, in the body-wall of XVIII and XX. Spermathecal setæ differentiated and ornamented in VIII and IX. Clitellum ring-shaped in XIII–XVII, saddle-shaped in XVIII. Genital zone, a quadrangular, glandular, ventral zone in XVIII–XX, in the corners of which lie the prostate pores. The two grooves are curved ventrally. No depressed area and no papillæ. Gizzards in V and VI. Sacculated intestine commences in XVIII; a dorsal typhlosole. Dorsal vessel alternatingly double and single in VI–XV. Hearts, four pairs in X–XIII. Nephridia, meganephridia, commence in II. Testes in X and XI. Sperm-funnels in X and XIX. Sperm-ducts join, but do not fuse until at the male pore in XIX. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Oviducts large. Spermathecæ, two pairs in VIII and IX. A large sac-like part and a thinner, irregularly bent, muscular duct; a small, stalk-like diverticle with a knob-like apex.

Septal formula:—

VI/VII, VII/VIII, VIII–IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV, XV/XVI.

Habitat.—Orange County, Florida. Specimens received from Professor Frank Smith.

DETAILED DESCRIPTION.

Body.—The somites of this species are much more distinctly set than those of any of the other species. The grooves are deep, the equatorials of the somites standing out boldly. None of the specimens possess a depressed genital zone. The copulatory grooves connecting the prostates and male pore are, on the contrary, situated on two elevated ridges, the whole zone being raised above the sexual surface of the body and more prominent than the clitellum.

The prostomium divides somite I about one-half. Somites II to IX increase gradually in width posteriorly. Somites VIII and IX are of about equal width. Somites X, XI, XII are about of the same width as somites VIII and IX. The papillæ on which are situated the spermathecal setæ are not very prominent.

The color of alcoholic specimens is grayish with a tint of brown on the dorsal anterior parts, undoubtedly due to pigment. According to Professor Smith the color is dark brown in life.

The tail of the worm is very characteristic. The last few somites are not only much narrower, but are also much shorter than any of the others. In three of the specimens the last seven or eight somites are half as long and a fifth as wide as the somites next anterior. They are of a pale whitish color prominently marked off from the deep gray of the other somites. In the fourth specimen only the last two somites are smaller and whiter. By width of the somite is meant the extension from head to tail; the length is the diameter across the body. These last somites appear as if they had been regenerated, but as all the specimens agree, I am inclined to consider this diminution in size a constant character.

Diplocardia riparia *Smith.*

PLATE XIII, FIGS. 143, 144.

Diplocardia riparia SMITH, Bull. Ill. State Lab. Nat. Hist., Vol. IV, 1895, p. 285.

Definition.—Color brown anteriorly and dorsally, clitellum dull coppery colored. Size 220–250 mm. Somites, 136–157. Prostomium divides somite I by one-half. Dorsal pores, most anterior one on anterior margin of XI, near X/XI. Spermiducal pores in XIX. Spermathecal pores, two pairs in VIII and IX, anterior to setæ *ab*. Prostate pores in XVIII and XX. Oviducal pores in XIV. Setæ as in *D. communis*, no ventral setæ *ab* in XIX. Distance *a–a*=*b–c*; *a–b* very little larger than *c–d*. Penial setæ in XVIII and XX. Spermathecal setæ not differentiated. Clitellum saddle-shaped, in XIII–XVIII. Genital zone, no rectangular ventral zone; a ventral depression in XVII–XXI, deepest in XVIII and XX. A pair of crescent-shaped grooves curved ventrally from center of XVIII–XX. Two papillæ very close to median line, between XXI/XX. One median papilla XVI/XVII, one pair papillæ XVII/XVIII, one pair papillæ XX/XXI, one pair papillæ XVII/XVIII. Gizzards in V, VI. Sacculated intestine commences in XVIII. Dorsal vessel single. Nephridia, meganephridia, a small pair in II. Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Prostates in XVIII and XX. Spermathecæ, two pairs in VIII and IX, with a large ear-like diverticle pointing forward, which is very prominent and exteriorly slightly racemose. Anterior

and posterior spermathecæ are of the same size. Septa (according to a section placed at my disposal by Professor Frank Smith):—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Havana, Illinois. Professor Frank Smith kindly furnished me several specimens.

DETAILED DESCRIPTION.

Genital Zone.—The genital zone is slightly sunken, very much as in Smith's specimens of *D. communis*, but to a lesser extent. The centre of the zone in XIX is higher, while the depression exists in XVIII and XX. But even the depressions are slightly elevated in the centre, so that there appear to be four separate depressions, one in each corner of the zone. The ridge surrounding the zone is very low. There is one pair of papillæ in the posterior part of XVII and one smaller pair in XX. One specimen possesses a large median papilla in XVI/XVII. In this papilla are seen two distinct depressions, giving it the appearance of being double. The papilla is strictly median and not in line with the papillæ of the zone, which latter are all in line with setæ *ab*.

Spermathecæ.—As these organs have not been figured, and as their shape is of considerable importance, I have thought best to give two figures (143, 144) of the two spermathecæ from the same side of a specimen.

Sperm-ducts.—According to longitudinal sections lent me by Professor Frank Smith, the sperm-ducts generally run between the cœlomic epithelium and the longitudinal muscular layer. Here and there, however, they are covered by a single strand of muscles. The same characteristic is also found in *D. communis*. According to a private communication to me by Professor Smith, the statement by Garman, that the ducts in *D. communis* run entirely in the muscular layer, is considerably misleading. Even in this species the ducts are merely covered by the cœlomic epithelium and not by muscular strands as in *Trigaster*.

Diplocardia Michaelseni *Eisen.*

Diplocardia Michaelseni EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, flesh. Size, 45 mm. by 2 mm., hardly tapering posteriorly. Somites, 63. Prostomium divides somite I completely. Dorsal pores, most anterior IV/V. Spermiducal pores XIX. Spermathecal pores, one pair preseptal in IX, one pair postseptal and almost central or median in VIII. Prostate pores XVIII, XX. Oviducal pores XIV, in front of and anterior to setæ *a*, close together. Setæ all ventral; *a–a*=3 *a–b*; *a–a* about one-third larger than *b–c*; *b–c*=about 2 *a–b*. Penial setæ present at spermiducal pore. Spermathecal setæ present in VIII, IX; setæ *a* and *b* being differentiated and sculptured. Clitellum ring-like, dorsally XIII–½ XVIII; ventrally XIV–XVII. Genital zone, a deep central, oval pit in XVIII–XX, surrounded by an elevated ridge. A pear-shaped ventral and median papilla in XXI and ½ XXII, and a similar papilla in ½ XXII and XXIII. Grooves between prostate pores are straight. A pair of deep, round pits in posterior part of XVII. No paired papillæ. Œsophagus straight or bent, not widening in any somite. Gizzards VI, VII. A large, thick glandular crop in XIV, XV. Sacculated intestine commences in XVIII. Dorsal vessel single (?), swollen in XVI, XVII. Hearts X, XI. Nephridia, meganephridia. Testes very large in X, XI. Ovaries are digitate. Sperm-funnels in X, XI. Sperm-sacs, three pairs, in IX, X, XII. Those in IX are preseptal, those in X and XII are postseptal, in IX only sperm-masses. Oviducts in XIV. Prostates occupy somites XVII–XXI, glandular part contains only one layer of cells, muscular duct folded, glandular part thick. Spermathecal duct muscular, long, folded, pouch large in two divisions; a large, oval, exterior diverticle, pointed forwards. The spermathecæ in VIII open anterior to setæ, those in IX open posterior to setæ.

Septal formula:—

VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII.

Habitat.—I possess a dozen specimens of this very interesting species, from Raleigh, North Carolina. Collected by Messrs. Brimley.

Occurs in swamps and in water under logs together with *D. Udei* and *D. singularis caroliniana.*

In this species, as in *D. Udei*, there are bundles of glands opening jointly in a pair of circular orifices in VIII and IX, between the sexual spermathecal setæ. These glands are interposed between the layers of the body-wall and the epithelial cells, and run parallel with the longitudinal axis of the body. Their structure is described more in detail in a memoir soon to be published by the California Academy of Sciences, San Francisco.

Affinity.—Diplocardia Michaelseni resembles *D. Udei* and *D. Eiseni* in possessing spermathecal sexual setæ accompanied by interior glandular structures in the body-wall. It differs from all other species so far described in the position of the spermathecal pores, which in somite IX are preseptal, while in somite VIII they are postseptal. As far as we know it also differs in the possession of a glandular crop in two of the clitellar somites similar to the one described in *Pontodrilus Michaelseni* (Eisen, 17).

EXTERNAL CHARACTERS.

Body.—The body is cylindrical, and does not taper either to head or end. The somites are not well marked off. The width is about the same at any point of the body, except at the clitellum, which widens a very little.

Somites.—The three anterior somites are much narrower than the others, and of about equal width, being about three-fourths as wide as IV, and one-half as wide as V. Somites V, VI, VII are of about the same width. The clitellar somites XIII to XVII are of about the same width or slightly wider and longer than the others.

The *prostomium* divides somite I entirely, reaching the intersegmental groove I/II.

Dorsal Pores.—Most anterior dorsal pore is between IV/V. Between II/III and III/IV there are slight depressions.

Spermathecal Genital Zone.—There is one pair of closely approximated papillæ in VIII and IX occupying about three-fourths of the ventral side of these somites. The papillæ are rosette-like, each with a central depression from which apparently protrude the sexual spermathecal setæ. In the posterior margin of IX, in line with setæ *ab*, are two preseptal spermathecal pores. In VIII no such pores are visible.

Postclitellar Genital Zone.—There is an oval sunk field in the ventral side of somites XVIII–XX, surrounded by a swollen margin protruding beyond the body line. This

field is connected anteriorly with two deep pits in the posterior margin of XVII. Somites XXI, XXII, XXIII are occupied by two large ventral pear-shaped swellings, as wide as the zone in XVII–XX. Each one of these pear-shaped swellings occupies one and a half somites. There are no other papillæ.

The *clitellum* appears ring-shaped and perfect, except for a V-shaped ventral depression in XIII and XIV. The clitellar somites are of even size and form and quite smooth. The intersegmental grooves are perfect.

Spermathecal Sexual Setæ and Glands. Setæ *ab* in VIII and IX are differentiated sexual setæ. They are strongly sculptured in about the same way as those of *Diplocardia Udei*, but the anterior part of the ridges are drawn out into short spines.

The setæ are accompanied by glandular structures in the body-wall, as far as I can see exactly like those in *Diplocardia Udei*, only not quite so numerous. They all open into a common globular chamber, there being no side chambers as in *D. Udei*.

Internal Characters.

Septa.—The enlargement of the septa is principally dorsal. This refers especially to the septa separating VII/VIII, VIII/IX, in which the dorsal part is two or three times wider than the ventral part.

Septal and Pharyngeal Glands.—The suprapharyngeal glands are well developed. There appear to be at least seven dorsal lobes. There are three pairs of very minute septal glands in VI, VII and VIII, situated close to the intestine and suspended by muscular strands. The one in VIII is the largest, and is at the widest part as wide as the wall of the intestine. Those in VI and VII are much thinner and one to three cells thick. A very interesting fact is that throughout the intestine in somites VII, VIII and IX are seen isolated dark-staining streaks, which upon examination are found to consist of glandular cells, exactly

like the septal glands. They are found between the epithelial cells and the muscular layers, the same as the septal glands, and differ from the cells of the glandular crop by their intense staining, and by their shape, which is also similar to the septal glands. They do not appear to discharge into the intestine. The glandular cells are apparently of the same nature as the septal glands. The glands in the crop in somites XIV and XV do not stain deeper than the epithelial cells, but rather more faintly, and not at all with the blue colors, as do the septal glands.

Spermathecæ.—In *Diplocardia Eiseni* both spermathecæ open immediately in front of the septa, and in the majority of the other species so far known the spermathecæ open posterior to the septa. The present species occupies an intermediate position in that one pair of spermathecæ are preseptal, while the other is postseptal. The preseptal pores are situated very close to the septum, but the postseptal pores are situated very near the center of the somite, in line with and immediately in front of setæ *ab*, —so near that the pores appear actually in the place where setæ *ab* are generally found, while these setæ have been pushed slightly backward. Setæ *ab* in somites VIII and IX are differentiated sexual setæ. In the only specimen sectioned the posterior spermathecæ are the longest, pushing backwards to the posterior end of X, but still confined in IX. Each spermathecæ consists of a folded muscular duct and a sac-like part, the latter strongly constricted at the centre. Each division is oval or semioval, in width about equal to one-fourth the diameter of the body cavity. The length of the sac-like parts of the spermathecæ in IX is equal to or even greater than the diameter of the body, or equal to the two somites IX and X. The spermathecæ in VIII are a little smaller, which probably is due to want of space to develop, they being crowded on one side by the gizzards and on the other by the spermathecæ in IX.

As regards structure the spermathecæ resemble those of *D. Udei*. The lower part, at least, of the muscular duct is surrounded by glandular cells and these again by stray

muscular strands. The diverticle of the spermathecæ in VIII is so large that it projects through the septum VII/VIII into VII. It does not seem to contain any trabeculæ.

Reproductive Organs.—Testes are large, in X, XI. Ovaries are strongly digitate, longitudinal sections showing six or eight narrow lobes starting from the septum.

Sperm-sacs.—There are three pairs of sperm-sacs surrounded by a peritoneal membrane. The pair in IX is slightly racemose and preseptal. The pair in X is not racemose, but still traversed by trabeculæ starting out from septum IX/X. They are thus postseptal. In XI there is a large sperm-mass like the pair in X, but there are no trabeculæ and there is no peritoneal membrane. The sacs in XII are strongly racemose and postseptal.

Prostates.—The prostates are large and thick, each one folded once. The outline is rough, wavy and warty. The muscular duct is well marked and folded two or three times. Each prostate occupies about two somites. They open as usual near sacs with penial setæ, but I am unable to say whether these are sculptured or smooth. The structure of the glandular part of the prostate is peculiar. The lumen is not wider than the lumen of the muscular part. This lumen is along its entire length ramified with tapering branches into which open the glandular cells. The lumen appears, both in the main canal as well as in the branches, to be lined by a thin membrane only, which probably must be considered as a reduction of the regular columnar epithelial cells which characterize the prostates of all higher Oligochæta except the Ocnerodrilini. This membrane contains, so far as I can see, no nuclei. The glandular part of the prostates is thus only one layer thick, all the cells being of the same quality. Around each branch of the lumen the glandular cells are arranged as around the lumen of a common prostate. They also open in the main lumen. Compared to the prostate of *D. Udei*, the parts of the present species are yet more reduced as regards the inner epithelium. In *D. Udei* I could now and then find a nucleated cell in the lining epithelium, while in *D. Michaelseni*

there are neither distinct cells nor nuclei. The branching of the lumen is more simple and regular in *D. Michaelseni* than in *D. Udei*.

Vascular System.—I find muscular connecting vessels or hearts in X and XI only. There is no supraintestinal dilatation of the dorsal vessel, as in some other species. The dorsal vessel appears to be single.

Intestine.—The gizzards are very short and thick and the connection between them is not thin, being about one-third as wide as the widest part. Œsophagus is straight. Tubular intestine is straight, slightly and gradually widening posteriorly. In XIV and XV we find the most characteristic part of the intestine. It consists of an oblong thick *glandular crop* of the same general structure as the one I have previously described in *Pontodrilus Michaelseni*. The crop consists of a thick glandular layer of cells which appears between the inner epithelium and the muscular layer. This layer consists of a great number of small cubical cells without any apparent ducts. But unlike *Pontodrilus Michaelseni*, no vascular blood loops are found penetrating the cell-layer, which appears homogeneous throughout. The part of the tubular intestine situated between the crop and the sacculated intestine, that is, from the posterior one-third of XV to the beginning of XVII, is strongly ciliated. The sacculated intestine is only very slightly wider than the tubular intestine.

Diplocardia Udei *Eisen.*

PLATE XI, FIG. 117; PLATE XIII, FIGS. 145–154.

Diplocardia Udei EISEN, Zool. Bull. Vol. II, No. 4, 1899.

Definition.—Color flesh, without any pigment; an even tint all around the body. Size, 70–90 mm. by 2 mm. at the widest part. Somites, 200–220. Prostomium divides somite I about two-thirds. Dorsal pores, most anterior one in anterior part of XI. Spermiducal pores in XIX. Spermathecal pores, two pairs, in front of setæ *b* on anterior part of VIII and IX. Prostate pores in XVIII and XX. Oviducal pore in XIV. Setæ: *a–a*=3 *a–b*; *a–a* slightly smaller than *b–c*; *b–c*=4 *a–b* (about); *c–d* not quite twice as wide as *a–b*; *d–d*

greater than half the periphery. In VIII, IX and X, a–a=1½ a–b. Penial setæ present, ornamented. Spermathecal setæ differentiated in VIII–X, highly ornamented, accompanied by glands in the body-wall. Clitellum dorsally XIII–½ XVIII, ventrally XIII–⅔ XXI. Genital zone a narrow, deep, rectangular depression, deeper than in any of the other species, surrounded by a thick, elevated ridge. Tubercula pubertatis in XIX–XXI, a pair of papillæ in XVIII. Most anterior septum III/IV. Œsophagus, no dilations containing calcic concretions. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single, thickly covered with chloragogen cells. Hearts in X–XII, with chloragogen cells. Meganephridia, no cœlomic mantle. Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one preseptal in IX, one postseptal in XII, both racemose. Oviducts small. Prostates very short and thick, occupying two somites each. Spermathecæ with a diverticle hidden in the wall of the spermathecæ, not perceptible except in sections. Anterior spermathecæ largest.

Septal formula:—

$$\overline{\text{VI/VII}},\ \overline{\overline{\text{VII/VIII}}},\ \overline{\overline{\text{VIII/IX}}},\ \overline{\text{IX/X}},\ \overline{\text{X/XI}},\ \overline{\text{XI/XII}}.$$

Habitat.—Raleigh, North Carolina. Collected by Messrs. Brimley.

This species comes nearest to *D. Eiseni* and *D. riparia*, without exactly being intermediate between the two. From *D. Eiseni* it differs in the position of the spermathecal pores and in the number of somites containing sexually differentiated spermathecal setæ, there being two such somites in the former and three in the latter species. There is also a pronounced difference in the genital zone, which in *D. Udei* is very deep, with straight fossæ. The species is smaller than *D. riparia*, its color is much lighter generally, being without pigment, and it possesses the sexual spermathecal setæ which are lacking in *D. riparia*. With those species possessing three pairs of spermathecæ *D. Udei* need not be confounded.

DETAILED DESCRIPTION.

Somites.—(figs. 145, 146.) The anterior somites increase in size towards the clitellum, with the exception of somites VIII, IX and X, which are much larger than the other somites. These somites also contain the genital setæ described elsewhere. Those somites anterior to VIII are all distinctly 3-ringed. Somites VIII, IX, X are perfectly

smooth; somites XI–XVI are 3- or 4-ringed. The clitellar somites are smooth, while those posterior to the clitellum are distinctly 5-ringed. The prostomium divides somite I by fully two-thirds. The clitellar somites are not very prominent and evidently not fully developed. Sections show that the clitellar glands are thin, extending dorsally from XIII–½ XVIII, while ventrally they could be traced to XXI. This posterior extension of the ventral part of the clitellum is due to the high glandular ridge surrounding the genital zone (fig. 146).

Genital Zone.—(figs. 145, 146.) This zone consists of a deeply sunk rectangular field in XVIII–XX, surrounded by a very high and swollen ridge of oval form, extending across the largest part of the ventral surface in somites XVII–XXI, where it connects with a low, median, ventral ridge of the body-wall. There are generally no papillæ, but in one specimen there was a trace of a pair of papillæ in XVII. The prostate pores are strongly elevated. The fossæ connecting them are straight, and not curved as in some other specimens. There are three pairs of small, rather pellucid fields in XVIII, XIX and XX, which I take to be tubercula pubertatis. Longitudinal sections show an arrangement of glands in these places similar to those found in tubercula pubertatis generally.

Setæ.—The distances between the setæ are not prominently characteristic. Distance *a–a* is about three times that of *a–b*. The ventral interval or *a–a* is only slightly larger than the lateral interval or *b–c*. The latter, *b–c*, is about four times as wide as *a–b*. The distance between setæ *c–d* is not quite twice that between *a–b*. The dorsal interval or *d–d* is greater than half the periphery of the equatorial.

In somites VIII, IX and X the ventral interval, *a–a*, is only about once and a half that of *a–b*, instead of being three times as great as in the other somites. This is due to the setæ *ab* being slightly more ventral in these three somites.

Spermathecal Sexual Setæ.—(figs. 50, 51.) Michaelsen was the first to discover the sexual spermathecal setæ in *Diplocardia*. These setæ have been found in *D. Eiseni*, *D. Udei*, and *D. Michaelseni*. In the former species they occur in two somites, VIII and IX, while in *D. Udei* they are found in three somites, VIII, IX and X. It is interesting to note that in the latter species somite X, which does not contain any spermathecæ, still possesses these sexual setæ. It is only setæ *ab* which are replaced by sexual setæ. The form of these is similar to curved penial setæ; they are much longer than ordinary setæ and quite slender (fig. 150). The apex is strongly and beautifully sculptured, as shown in figs. 151, A and B. Under a low power the sculpture appears like bristles, but under a good apochromat we see that what appears to be bristles are but short curved ridges, each one enclosing a flat oval field with a granular sculpture. There is no difference between these setæ in IX and X. Each one of the setæ protrudes through a pore surrounded by a pale elevated ring or circular ridge and the body-wall surrounding the two setæ is elevated, appearing as if strongly glandular. This causes the ventral side of somites VIII, IX and X to appear much swollen and also wider than the other surrounding somites.

Glands of the Sexual Setæ.—(fig. 154.) The external elevation of the body-wall around the spermathecal setæ is connected with an interior differentiation of structure. Michaelsen has described somewhat similar structures in *D. Eiseni*, but judging from Michaelsen's description they differ considerably from those found in *D. Udei*. Unfortunately Michaelsen does not give any figures, so that a minute comparison is not possible. He described them as structures without distinct cell-walls, but with numerous nuclei. I suspect that this absence of cell-walls may be due to degeneration.

In *Diplocardia Udei* I find that an extra layer of glandular cells has made its appearance between the muscular layer and the epithelium (fig. 154). Some of these cells protrude between the muscular fibres, but the majority are pushed in

between the epithelial cells. These glandular cells bear a strong resemblance to the tubercula pubertatis cells described from *Dichogaster Crawi*, but they have the peculiarity of opening into a chamber surrounding the apex of the seta. This chamber opens to the exterior through the setal external pore, which, as before stated, is surrounded by a slightly elevated ring. Thus the glandular cells extend from the various ventral parts of the somite, their ducts leading to this pore. The distal ends of the cells are all bent upwards or downwards, but the long narrow ducts run parallel and close together until they reach the pore. The secretion in these cells stains but faintly, and in this respect resembles that of the tubercula pubertatis. Figure 154 represents a longitudinal section of this glandular zone. The seta comes in from above, but has been cut off obliquely. The chamber into which the glands open is furnished with side pockets into which some of the glandular cells open. The walls of all the cells are very distinct. The cœlomic epithelium in somites VIII, IX and X is granular and resembles chloragogen cells. The cell-contents consists of small and numerous round, dark-staining granules. The cells themselves are of different sizes, protruding more or less freely and independently into the cœlomic cavity, while their thin ends lose themselves among the muscular layers.

Another interesting feature of this glandular structure is a double row of cells as in a prostate. The long glandular cells may readily be compared to and are perhaps homologous with the long glandular cells of a common prostate, while the narrow cells lining the chamber into which the former cells open are similar to the inner layer of cells of the prostate. If the whole structure had been free in the cœlom instead of being enclosed by the layers of the body-wall, its similarity to a prostate would have been almost complete. This fact gives great probability to the opinion of Michaelsen, that the prostates are differentiated cell-structures originally connected with setæ.

Penial Setæ.—(figs. 152, 153.) These setæ are present and not rudimentary; they are very minute, curved, and of unequal length. The longer seta is very slender, several times longer than ordinary setæ. The shorter seta is thicker and undoubtedly not yet developed. The apex of the longer seta is hooked and sculptured. The sculpture is different from that of the spermathecal setæ and less elaborate. There are rows of spine-like elevations combined with depressions difficult to describe.

Septal and Pharyngeal Glands.—Besides the usual mass of suprapharyngeal glands there is also a row of subpharyngeal glands of small size, on the ventral side of the pharynx, opening into its posterior part. There are very small septal glands in VII, VIII and IX, attached to muscular strands coming forwards. The longitudinal diameter of these glands is no greater than the diameter of the dorsal vessel, and in longitudinal sections they appear to be of the same size as the isolated subpharyngeal glands.

Intestine.—The œsophagus is very narrow and tubular; it curves upwards from the pharynx. The tubular intestine runs straight on from the gizzards to the sacculated intestine and is thickly surrounded by chloragogen cells. It is only slightly nipped by the septa. The sacculated intestine commences in XVII.

Spermathecæ.—(figs. 147, 148.) The two pairs of spermathecæ occur in VIII and IX. In the specimen dissected, as well as in the one sectioned, the anterior spermathecæ are much longer and narrower than the posterior ones. I have observed this to be the case also in *D. singularis* subsp. *caroliniana*, and it may possibly be characteristic. The diverticle is hardly, if at all, perceivable from the exterior. In one spermatheca no exterior diverticle could be detected, in the other there is only the slightest swelling. In sections the spermathecal diverticle is distinct enough, forming a cavity in the spermathecal wall. It is divided into several chambers by trabeculæ. Figures 147

and 148 represent one of the anterior and one of the posterior spermathecæ from the same specimen. The figures were drawn from three sections. There is a muscular duct not perceived from the exterior, being hidden by the other spermathecal tissue.

Sperm-sacs.—There are two pairs of sperm-sacs, both strongly racemose, resembling those of *Diplocardia carolin-iana*. The pair in IX is preseptal, that in XII postseptal.

Prostates.—(fig. 149.) The four prostates are very compact and when dissected appear as square irregular masses. One of the prostates possesses a thin distal end doubled on the main body of the prostate. The muscular duct is narrow, slender, and coiled. The prostates do not project dorsally and are confined respectively to one and two somites. The penial setæ opening with the prostates are not half as long as the muscular part of the prostate.

The structure of the glandular part of the prostate is interesting as it shows a reduction of the inner epithelium. The lumen is very narrow, narrower than the lumen of the muscular part. It is numerously and irregularly branched, the glandular cells opening into the branches as well as into the main lumen. The whole prostate forms a single system of glands, the secretions of which all flow into the common narrow lumen. This lumen is lined, not by the regular columnar epithelial cells, but by a thin nucleated membrane, with here and there a few very small, distinct cells. The prostate is in reality racemose, appearing tubular exteriorly. See also the description of *D. Michaelseni*.

Nephridia.—The nephropores are in line with setæ *d*. In form the nephridia closely resemble those of *A. Keyesi* which have been figured elsewhere (Eisen 18). The windings and the spur are more folded and twisted. There is no cœlomic mantle.

Vascular System.—So far as can be judged from longitudinal sections the dorsal vessel is single. There is a peculiarity in the intestinal blood-sinus of some of the sexual

somites. The blood-sinus suddenly leaves the intestine on the dorsal side and assumes the form of an independent blood-vessel, running close to the intestine, and parallel with the dorsal vessel. This supraintestinal vessel exists only in somites XI and XII. It begins near the posterior fourth of XII and extends forwards to the septum separating X/XI. In the posterior of these two somites the supra-intestinal vessel lies entirely free above the intestine except where it is nipped by the septa. In somite XI it is superposed on the intestine and merely connected by mesenteric tissues with the dorsal vessel in those somites. It is not covered by chloragogen cells; these, however, cover the dorsal vessel, the hearts, and the intestine. The hearts are not much dilated, but appear as tubular vessels of even thickness, without valves. The lateral vessels posterior to the clitellum are covered thickly with chloragogen cells. As in *A. Keyesi*, each lateral vessel possesses a small diverticle, situated in the centre of the vessel. The present species is more pronounced than in *A. Keyesi*, being narrower and often twisted around the lateral from which it starts. In *A. Keyesi* two such diverticles are found, but they are smaller and more knob-like.

Diplocardia communis *Garman.*

Diplocardia communis GARMAN, Bull. Ill. Lab. Nat. Hist., Vol. III, 1888, p. 47.

Definition.—Color, flesh; clitellum dull yellow or flesh. Size, 300 mm. Somites, 123–165. Prostomium divides I by one-half. Dorsal pores, most anterior one X/XI. Spermiducal pores in XIX. Spermathecal pores, three pairs in VII–IX, in line with *a–b*. Prostate pores in XVIII and XX. Oviducal pores close together in front of and interior to setæ *a–b*. Setæ, ventral, *a–a* slightly larger than *b–c*, not ornamented; no setæ *a–b* in XIX. Penial setæ in XVIII and XX, only slightly curved, smooth, one-third longer than ordinary setæ. Spermathecal setæ not differentiated. Clitellum saddle-shaped, in XIII–XVIII. Genital zone, copulatory papillæ: one pair on XVII, one pair on XX. Copulatory grooves on XVIII–XX, curved towards the ventral median line. With or without a depressed zone. Œsophagus, no calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII, a low typhlosole from XXIII–XL. Dorsal vessel alternately double and single from VII backwards. Hearts in X–XII.

Meganephridia, most anterior one in III. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts run on top of muscular layer, between it and the cœlomic epithelium. They join only at the pore. Sperm-sacs in IX preseptal, in XII postseptal. Prostates long, slender, tubular, abruptly bent at the pore, sometimes extending over more than one somite. Spermathecæ, three pairs in VII–IX, club-like, with an ear-shaped diverticle below the center.

Septal formula (approximately correct):—

VI/VII, VII/VIII, $\overline{\text{VIII/IX}}$, $\overline{\text{IX/X}}$, $\overline{\text{X/XI}}$.

Habitat.—Champaign, Illinois. Collected by Professor Garman. Through the kindness of Professor Frank Smith, I have in my possession four specimens collected by Professor Garman, and three specimens collected by Professor Smith himself. The former differ from the latter in the character of the genital zone. It is well worth the while to examine a large number of specimens in order to ascertain if there are not two distinct species now joined under the name of *D. communis*.

Genital Zone.—Specimens collected by Professor Garman: No. 1. No signs of a depressed genital area. There is one pair of comparatively large papillæ in the posterior part of XVII, just clearing the groove of XVII/XVIII, with their bases slightly encroaching on XVIII. Besides this pair there are three pairs of smaller papillæ in the posterior parts of XX, XXI and XXII, similarly very slightly projecting across the intersegmental grooves posteriorly. No. 2. One pair of papilla in XVII, and one pair in XX, situated as in No. 1. No. 3, similar to No. 2. In all these specimens the papillæ of the anterior pair are the largest.

In each one of the specimens collected by Professor Smith there is a depressed genital zone not existing in Garman's specimens. This zone is oblong and almost rectangular. It is surrounded by an elevated ridge similar in shape to that found in *D. Udei*, but it is not so high. This ridge extends from ½ XVII–⅓ XXI, while the depressed zone extends from XVIII–⅓ XXI. Inside the ridge there is in specimen No. 1 a pair of papillæ in the posterior part of each of somites XVII and XX and one pair

in XXI. No. 2. One pair of papillæ in XVII, one pair in XX similarly situated. Besides there is one pair of papillæ in the posterior part of XIV, in line with the papillæ of the zone and of the same size or slightly larger. These two papillæ are situated on an elevated zone, or, in other words, are surrounded by an elevated ridge which is closed in front but open behind; it extends to the center of XV. No. 3 is similar to No. 2 but has no papillæ in XIV. In the three specimens the papillæ in XVII are larger than the posterior papillæ.

The depressed zone is not of uniform depth in the three somites, being much deeper at the anterior and posterior ends. In the part occupied by somite XIX the zone is hardly deeper than the main part of the somite, while in XVIII and XX–⅓ XXI the zone is deeper at the end and appears like two separate cavities, separated by a central bar in XIX. There are tubercula pubertatis swellings in XIV to XVII, but with no decided external characteristics.

Diplocardia singularis *Ude.*

Geodrilus singularis UDE, Zeit. f. wiss. Zool. Bd. LVII, 1894, p. 69.

Definition.—Color dark brown. Size 65 mm. by 3 mm. Prostomium divides somite I about one-half. Dorsal pores, most anterior one VII/VIII. Spermiducal pores in XIX. Spermathecal pores, three pairs in VI/VII, VII/VIII, VIII/IX. Prostate pores in XVIII and XX. Oviducal pore in XIV, interior to setæ *a*, surrounded by a glandular ridge. Setæ, ventral, lateral; *d–d* greater than half the periphery; *a–a* larger than *b–c*; *c–d* somewhat larger than *a–b*; *a–b* about one-half as large as *b–c*; *l. i.* shorter than *v. i.*; *a–b* half as long as *l. i.*, and three times shorter than *v. i.*; faintly ornamented at apex. No setæ *a–b* in XIX. Penial setæ three times as long as the ordinary setæ, curved, not ornamented. Spermathecal setæ not differentiated. Clitellum, ring-like, XIII–½ XVII, saddle-shaped, ½ XVII–XVIII. Genital zone, no rectangular field, two lunate grooves on ½ XVIII–½ XX, convexity towards ventral median line. One pair papillæ in XVII. One pair in XX. Sometimes with a deep oval zone in XVII–½ XXI (Smith's specimens). Œsophagus strongly twisted, bead-like in X–XIII, narrower in XIV–XVI, no calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single. Hearts, three pairs in X–XII; in VI–IX narrow vessels. Meganephridia, first pair, in II, small; pores ventral to setæ *d*. Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one pair in

IX preseptal, one pair in XII postseptal. Prostates with many folds at right angles. Spermathecæ, three pairs in VII-IX, sac-like, gradually narrowing duct, oblong diverticle.

Habitat.—Havana, Illinois. Four specimens (size 90x2 mm.) from this locality, kindly sent me by Professor Frank Smith of Champaign, Illinois. Three of the specimens are adult.

No attempt was made to section and dissect the specimens. They were labeled by Professor Frank Smith and determined by him. They are much longer than Ude's specimens and also narrower. In the table of species I have retained the description given by Ude, as future investigation of the Havana specimens may reveal differences.

Genital Zone.—The genital zone agrees in a general way with the figure given by Ude, but differs in one point. There is a very marked depressed area of oval shape occupying the ventral side of somites XVIII to ½ XXI, just posterior to the clitellum. When the worm is viewed from the ventral side this area is seen to occupy about one-half the width of the somite; that is, there is left on either side of the depression about one-quarter of the width of the somite. There is a very slight ridge bordering the depression, which is well defined and sufficiently deep to appear quite dark. There are two pairs of papillæ, one pair in XX/XXI, the other in the groove separating XVII/XVIII.

Anterior Somites.—The prostomium divides somite I about three-fourths. Somites I and II are about one-half as wide—in direction of head to tail—as somite IV. Somite III two-thirds as long as IV. These anterior three somites are thus distinctly shorter than the following ones. The anterior nine somites are more or less corrugated; the others are smooth. The clitellum occupies dorsally ½ XIII–½ XVIII, ventrally ½ XIII–¾ XVII. In XVII the clitellum leaves a ventral space occupied by the anterior pair of the papillæ. One specimen does not possess any papillæ.

Diplocardia singularis *Ude*, subsp. caroliniana *Eisen*.

PLATE XIII, FIGS. 137–142.

Diplocardia singularis UDE, subsp. *caroliniana* EISEN, Zool. Bull. Vol. II, No. 4, 1899.

Definition.—Color flesh, without pigmentation. Size, 40–50 mm. by 1.5 mm. Somites, 64, 98–136. The prostomium divides somite I about one-half. Dorsal pores, most anterior on the front part of IX. Spermiducal pores in XIX. Spermathecal pores in VII–IX. Prostate pores in XVIII and XX. Oviducal pores in XIV, on a small glandular area. Setæ as in the species, but *a–b* is about twice as long as *a–a*; *a–b* is less than one-half as wide as *b–c*, all faintly sculptured. No setæ *a–b* in XIX. Penial setæ curved, pointed, and ornamented. Spermathecal setæ not differentiated. Clitellum ring-like, except in anterior part of XVIII, where it is saddle-shaped, XIII–½ XVIII. Genital zone not much differentiated. Two curved grooves, with the convexity turned to the ventral median line. In XVII two large circular areas, like depressed papillæ. In XXI two similar areas. In XXII one median oblong area. Œsophagus without calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single, with chloragogen cells. Hearts, muscular vessels in X–XII, with chloragogen cells. Meganephridia. Testes in XXI. Sperm-funnels in X and XI, compact. Sperm-sacs, one pair in IX preseptal, one pair in XII postseptal. Oviducts, very large protruding funnels in XIII. Prostates large, tubular, almost straight, one-third as wide as the body-cavity. Spermathecæ, three pairs in VII–IX; the anterior pair the smallest; the two posterior pairs the largest. Each of the latter extends through two somites backwards. The diverticle is longitudinally oblong, with a distinct stalk or duct, and divided into several chambers by trabecula.

Septal formula:—

$$\overline{\text{VII/VIII}},\ \overline{\text{VIII/IX}},\ \overline{\text{IX/X}},\ \overline{\text{X/XI}}.$$

Habitat.—Raleigh, North Carolina, U. S. A. Found under logs and in rotten wood in swamps in the vicinity of the city. Fifty odd specimens were received alive during the first half of January, 1897, from Messrs. Brimley.

In the location and number of the various organs this form does not apparently differ from *Diplocardia singularis* Ude, but the size and shape of the spermathecæ and prostates, and the form and ornamentation of the penial setæ are so at variance with the description and figures of *D. singularis* given by Ude that it seems advisable to classify the specimens from Raleigh, North Carolina, under a separate subspecies. To the differences referred to above we may also add absence or scarcity of papillæ on the clitellum, four of which occur in *D. singularis*.

The following description will be confined to the points of difference between the species and subspecies. A closer comparison can only be made through a study of type specimens of the species.

EXTERNAL CHARACTERS.

Color.—The whole worm is semi-transparent, of a delicate flesh-color, with blood-vessels appearing through the skin. The spermathecæ and prostates appear as white masses through the skin.

Somites.—The somites are all faintly three-ringed. The clitellar somites XIII–½ XVIII are much more distinct and wider than the somites posterior to them. According to the figure given by Ude the clitellar somites of *D. singularis* are of about the same width as the somites posterior to them. The clitellum ends posteriorly and dorsally with the centre of XVIII, but ventrally with the posterior margin of XVII. In *D. singularis* the clitellum appears to extend to the posterior part of XVIII, while ventrally it does not cover the whole of XVII.

The *prostomium* (fig. 137) divides somite I by almost two-thirds. It is bounded posteriorly by a deep transverse groove which extends across the whole somite in the direction of the short diameter of the body.

The *dorsal pores* begin in IX. The pores increase gradually in size posteriorly, those immediately in front of the clitellum are larger. The pores in the clitellar somites are also distinct. The most anterior pore is situated on the anterior part of IX. In several somites anterior to the first dorsal pore there are deep depressions which appear, when viewed from the surface, as narrow pores. Longitudinal sections show that these depressions do not penetrate the body-wall. Undoubtedly such depressions have sometimes been mistaken for true pores.

Genital Zone.—(fig. 137B.) There are two slightly curved grooves with the convexity towards the median line. They are slightly wavy and surrounded by a slight

swelling. Of these swellings those surrounding the prostate pores and penial setæ are the largest and sometimes appear as elevated papillæ. There are no real elevated papillæ in the surrounding somites in any of the specimens; in their place are small, round fields, semitransparent and undoubtedly of a nature similar to the papillæ. Of these fields there are two very closely joining in XVII, posterior to the setæ and occupying the continuation of the ventral interval *a–a*. Two similar areas are in XXI, while in XXII there is a more oblong area, median in position, covering the whole ventral interval *a–a* posterior to the setæ. Only the specimens most fully developed possess these flat papillæ.

Setæ.—The common setæ are like those of *D. singularis*, but the ventral interval *a–b* is less than half that of the lateral interval *b–c*. According to Ude, in *D. singularis* *a–b* is equal to one-half of *b–c*. The setæ are all sculptured, but the sculpturing is more in the shape of notches than that represented in Ude's figure 11. The shape of the setæ is also different, the posterior part being much heavier in *D. caroliniana*.

The penial setæ (figs. 139, 140) differ somewhat from those of *D. singularis*. They are about three times as long as the common setæ. They are more pointed than those of *D. singularis* as figured by Ude and the apex is more twisted. The most important difference is found in the sculpturing of the setæ, which are not smooth as in *D. singularis*. The sculpture is represented in fig. 140. It does not begin at the apex, but some distance below it. There are from eleven to fourteen small distinct notches on either side. The two setæ in each bundle are practically alike.

INTERNAL CHARACTERS.

Spermathecæ.—(figs. 141 A and B.) There are three pairs of spermathecæ as in *D. singularis*, situated in somites VII, VIII and IX, with the pores in front of the setæ. They differ in shape from those of *D. singularis*, being much longer and narrower, and with the exception of those in VII, extending through two somites instead of being confined to

one as in that species. This difference in size would, however, be of less importance were it not coupled with a change in the form of the diverticle. Ude describes and figures the diverticle of *D. singularis* as being transversely oval with a short shaft. In the subspecies *caroliniana* the diverticle is longitudinally oblong and the apex knob-like. This was found to be constant in the three specimens opened.

Septal and Pharyngeal Glands.—The pharyngeal glands are also developed ventrally, though they are here much smaller than on the dorsal side. Dorsally they are long and in cross-sections present a row of about seven glandular masses attached to as many muscular strands. On the under side of the pharynx, just above the ventral nerve-cord, there is a row of narrow and short glands, also attached to muscular strands, one following the other, just as on the dorsal side. These ventral glands open into the ventral part of the pharynx near its posterior margin. There are also small septal glands close to the œsophagus in somites VII and VIII.

Prostates.—(fig. 142). The prostates are much larger and of different form from those of *D. singularis.* Ude's figure does not show the muscular duct, and his description does not mention its relative size to the glandular part; but the glandular part which he figures is certainly very much narrower in proportion to its length than what we find in the subspecies. In the former the glandular part is five or six times the width of the duct. This glandular part was the same shape and size in the three specimens examined by me. In width it equals about one-third or more of the body-cavity of the worm; it is scarcely folded, slightly irregular and nipped, and extends through three or four somites. The posterior prostates appear to be a trifle more folded and extend backwards. Thus the prostates opening in XVIII occupy XVI, XVII, XVIII and XIX, while those opening in XX occupy XX and XXI and sometimes part of XIX. Two figures are given of two prostates on one side in the same specimen.

Blood-vessels and Hearts.—The dorsal vessel is single. There are three pairs of muscular vessels in somites X, XI and XII, which probably serve as hearts. They are not greatly extended, nor are they divided into pulsating chambers separated by valves, as in *D. Keyesi*. The hearts are covered by chloragogen cells. The dorsal vessel is similarly covered. The blood-sinus in the dorsal part of the intestine in X, XI and XII rises above the muscular layers of the intestine and forms a kind of supraintestinal vessel. In none of these somites is this vessel so free as in *D. Udei*, being everywhere attached to the intestine, though elevated above it. In *D. Udei* the part in XII is entirely separated, while the one in XI is only superposed on the intestine.

Intestine.—There are no dilations of the œsophagus. The sacculated intestine commences in XVII. There is a typhlosole in XX–XIV.

Subgenus **Naillenia**, subgen. nov.

Diplocardia (Naillenia) Koebeli, sp. nov.

Plate XIV, Figs. 177, 178.

Definition.—Size 80–100 mm. by 2 mm. Somites about 100. Prostomium divides somite I about one-half. Dorsal pores, VII/VIII. Spermiducal pores in XVIII. Spermathecal pores in VIII and IX, both pairs postseptal. Spermathecal sexual setæ in IX. Penial setæ large, curved in XVII and XIX; sculptured, with spines. Exterior papillæ, one pair on IX, one large median papilla covering posterior part of X and anterior part of XI; a large median papilla on XIV and XV; a large median papilla between XIII and XXIV. Sacculated intestine commences in XIV, thence to XXIII it possesses an interior thick and greatly folded epithelium. Spermathecæ large, with a very large and thick diverticle directed forwards. Prostates thick and long, each occupying at least two somites, opening into XVII and XIX.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Habitat.—About a dozen specimens, of which five were adult, taken by Professor Albert Koebele at Morelos, Mexico, at an altitude of 6,000 to 7,000 feet, in the region of the pines, September, 1897. Though otherwise fully developed sexually, none of the specimens possess a clitellum.

The subgenus is named for Professor A. Van der Naillen of San Francisco. This very interesting form differs from all other members of the genus in the position of the spermiducal pores, in XVIII, showing the extent of the variation of these pores in the same genus. It stands at one end of the series, while *Diplocardia Keyesi* stands at the other, giving an extreme variation of four somites in which are located the male pores. *D. Koebelei* differs from all other species of *Diplocardia* in not possessing racemose, preseptal sperm-sacs in IX, a character which seems to join it more closely to the *Benhamia* group, and perhaps to *Trigaster*.

DETAILED DESCRIPTION.

Somites.—Somite I is dorsally as wide as somite III, ventrally as wide as somite II. Somites II and III are narrower than those following, which slightly increase in size posteriorly, at least as far as X or XII.

Clitellum.—The clitellum is not developed in any of the specimens, and it is possible that it is altogether absent. The large papillæ surrounding the prostate pores may serve as a substitute for a clitellum. These papillæ show the same structure as that described in the tubercula pubertatis of *Pontoscolex*, except that the glandular cells are much larger and extend not only into the muscular layers, but far beyond them into the cœlomic cavity of the body. These glandular masses form a continuous stratum on the ventral side of somites XVII, XVIII and XIX, but are especially developed back of the prostate pores, where they extend to the centre of the cœlomic cavity, touching the sides of the intestine. These glands do not open into any special pore, as is the case in some other species where, for instance, they open into the papillæ of the spermathecæ. They open on the surface in exactly the same manner as the large glandular cells of the clitellum. The glands do not occur singly, but in bunches. I am inclined to regard them as modified clitellar cells.

The *genital zone* in somites XVII–XIX is square, the grooves being straight and parallel, bounded by ridges connecting the papillæ around the prostate pores.

Papillæ.—The papillæ surrounding the spermathecal pores, as well as the single median papillæ on X/XI and XIV/XV, show a structure similar to that of the spermathecal papillæ figured for *D. Udei*, except that the cells are much narrower, though fully as long. In the papillæ on XIV/XV these long horizontal cells open into two pores situated in line with the ventral couples of setæ, in the intersegmental groove between these two somites.

Setæ.—The *penial setæ*, opening at the prostate pores, are very long and much curved, like a sickle with a reflexed, sharply pointed apex. Along the whole length the seta is ornamented with some twenty or more rows of short scale-like spines, hardly projecting from the main body, except at the recurved part of the apex, where the spines are a little longer. One specimen has curved penial setæ in somite XVIII. They are much smaller than those in the prostate papillæ, but much larger than the ordinary setæ. The specimen sectioned did not have these setæ, and I suppose their presence is abnormal.

Spermathecal setæ are present in the two papillæ in somite IX. There are two setæ in each papilla, pointing forwards; they are about twice as long as the common setæ, almost straight, with the apex slightly spatulate, and appear to be somewhat ornamented, in the same manner as the penial setæ. A description of the exact structure cannot be given, as it was desired not to mutilate the specimen.

The *common setæ* are sigmoid as usual. Their position posterior to the clitellum may be expressed as follows:—

d–c=15; c–b=85; b–a=20; a–a=85; a–b=20; b–c=85; c–d=15.

d–c=20; c–b=80; b–a=15; a–a=90; a–b=15; b–c=80; c–d=20.

d–c=20; c–b=85; b–a=20; a–a=90; a–b=20; b–c=85; c–d=20.

The above shows a slight variation, partly actual and partly due, perhaps, to unequal stretching of the body-wall.

Anterior to the male pores the distance between setæ *c* and *d* is somewhat greater. The arrangement may be given as follows:—

d–*c*=20; *c*–*b*=55; *b*–*a*=12; *a*–*a*=45; *a*–*b*=12; *b*–*c*=55; *c*–*d*=20.

As regards the size of the setæ, it is interesting to note that while those posterior to the male pores are all of about the same size, those between the male pores and the front part of the body vary in such a way that the ventral setæ are about twice as large as the lateral. The apices of these setæ are slightly ornamented with five to six rows of shallow notches, resembling the undeveloped eyes of a potato.

Gizzards.—The two gizzards are well developed and situated in somites V and VI.

Intestine.—The tubular intestine offers nothing characteristic. It is straight and only slightly nipped by the septa. The sacculated intestine commences in XIV. It is of characteristic structure. The outer wall of this part of the intestine in somites XIV to XXI is straight, but the inner layer comprising the villi is much folded, being besides very thick. This inner epithelial layer is thicker and more folded than any other epithelial layer of the intestine, and is probably of the nature of a typhlosole. In somite XX the sacculated intestine assumes the usual shape, with thin walls not folded.

Generative Organs.—The testes are in somites X and XI. There are two pairs of large racemose sperm-sacs projecting from the anterior septum, in somites XI and XII. The sperm-funnels are in X and XI. The ovaries in XIII. The ovipores are separated. The spermathecæ are very large, each being furnished with a large forward pointing diverticle, originating near the base of the main sac, the junction of the two being very wide and the diverticle within a neck. The spermatozoa are collected in small pockets in the wall of the sac, in the same way as in *Argilophilus*, the pockets being somewhat smaller than in that genus (Eisen 16).

The spermathecal pores are found on the anterior face of the somite, about half-way between the setæ and the bottom of the intersegmental grooves. The glandular prostate contains two layers of cells.

Septa.—The septa do not strictly correspond to the intersegmental grooves, but start out almost from the centre of the somites.

The *septal glands* are very diminutive in somites IV to VII and in X. They are attached to the blood vessels. The suprapharyngeal glands are of medium size.

The *brain* is situated in somite II.

The *tubular intestine* and the anterior segments of the sacculated intestine are furnished with chloragogen cells. Similar cells also surround the dorsal vessel. Sections show that the most anterior dorsal pore is between somites VII and VIII.

The *nephridia* commence in somite IV. Their structure has not been studied, but it appears to be similar to that of the nephridia of the other species, that is meganephridia, resembling those of *Diplocardia Keyesi*.

The *dorsal vessel* is double. In XI and XII it is narrow and tubular; in XIII to XVI it is much wider.

Color.—As far as could be judged from specimens preserved in formalin, the color is pale flesh without any trace of pigment.

The species is named for Mr. Albert Koebele, Horticultural Entomologist of the Hawaiian Government, to whom I am greatly indebted for a number of most interesting species which he collected in Mexico.

Trigaster *Benham.*

Definition.—Setæ paired, eight in each somite. Clitellum long or short. Gizzards two or three. Nephridia plectonephric. Spermathecæ two pairs, in VIII and IX, with or without diverticle. No diverticles of the intestine. Prostates two pairs, open in the somites anterior and posterior to the male pores, which are in XVIII. Penial setæ present or absent. Sperm-ducts are completely hidden in the muscular layer of the body-wall.

General Remarks on Affinity.

It is not without some hesitation that I have modified the generic definition of this genus as given by Benham, in order to be able to arrange in it the new species to be described hereafter. On the other hand, if a new generic name is to be made for our new species, its characterization would rest mainly on negative characteristics, viz., the possession of two gizzards instead of three, and on the lesser extent of the clitellum. For the present, it seems preferable to refer the new species to the old genus *Trigaster*, and to modify the definition of the genus rather than to create an uncertain one. The hidden nature of the sperm-ducts is probably characteristic of all the species.

The question will undoubtedly arise as to why this genus has been made to include a species with only two gizzards, when the genus was founded upon a species characterized by three gizzards. The answer is found in the fact that *T. tolteca* more closely resembles Benham's (3 and 13) species *T. Lankesteri* than any other species or genus known. It possesses all the important features of Benham's species, the only great difference being in the number of gizzards. Perhaps the most important character of *Trigaster* will be found in the hidden course of the sperm-ducts. While this is not demonstrated in *T. Lankesteri*, it is more than probable that it will be found to be the case even in this species. Benham did not find the sperm-ducts and the probable reason for this is that they are hidden in the body-wall.

If the want of a gizzard should exclude *T. tolteca* from the genus *Trigaster*, then a new genus must be created. The species cannot be united with *Benhamia*, differing, as it does, in too many important points. It possesses plectonephridia instead of micronephridia; it has no diverticles of the intestine; and finally, its sperm-ducts are hidden in the body-wall. *Zapotecia ameca-mecæ* resembles Benham's original *Trigaster* species in most particulars, but differs in having meganephridia instead of plectonephridia.

The hidden nature of the sperm-ducts is characteristic of both species of *Trigaster*. This character is also found in two species of *Diplocardia* but to a lesser degree, the ducts being merely covered by the peritoneum or by a strand or two of muscles. In the absence of diverticles of the intestine *Trigaster* resembles the other genera of this family. This character seems to me to be of the greatest importance and I consider it to be the distinguishing feature between Diplocardinæ and Benhaminæ.

The two species of *Trigaster* may be distinguished as follows:—

Trigaster tolteca, two gizzards, in V and VI.

Trigaster Lankesteri, three gizzards, in VII, VIII and IX.

Trigaster tolteca, sp. nov.

PLATE XIV, FIG. 179.

Definition.—Length over 120 mm., width below clitellum 5 mm., at the tail 9 mm. Somites 190. Setæ in couples, the ventral ones closer than the dorsal. Penial setæ at the prostates curved and smooth. Prostomium barely indentates somite I. Dorsal pores posterior to clitellum. Clitellum in XIII–XIX. Genital zone almost square, sunk, with two parallel fossæ. A small median papilla on XX. Two gizzards in V and VI. No diverticles of the intestine. Very small septal glands extending to somite IX. Small subpharyngeal glands present. Racemose sperm-sacs in XII growing out from the dorsal vessel. Spermathecæ without diverticles, in VIII and IX; the pores in the intersegmental grooves VII/VIII, VIII/IX, postseptal. Testes and sperm-funnels in X and XI. Ovaries in XIII. Sperm-ducts hidden in the longitudinal muscular layer of the body-wall, fusing at the pores in XVIII. Prostates tubular, in XVII and XIX. Nephridia consist of many isolated tufts, commencing in III. Dorsal vessel double in X, XI, XII (?). Hearts very muscular, the last one in XIII. Color pale; no pigment.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Toluca, Mexico, in the pine-region at an altitude of 8,000. Collected by Professor Albert Koebele.

Of the single specimen one-half of the anterior end was sectioned lengthwise, the other half crosswise. The part sectioned longitudinally exhibits the following anomaly:

The anterior prostate, in XVII, is double, as regards both the glandular and the muscular part. A single large prostate opens with the sperm-ducts in the equator of somite XVIII. With this prostate opens also a pair of penial setæ exactly similar to those in XVII and XIX. The other side of the worm does not exhibit these peculiarities.

DETAILED DESCRIPTION.

Owing to the indifferent state of preservation of the single specimen, but few details can be given. The spermathecæ are very large and have the form of elongated sacs without diverticles. The upper end of the sac is somewhat wider than the lower half near the pore. The walls are very thick. The upper, larger chamber is lined by very long columnar epithelium. The lower part exhibits a very peculiar structure. The lumen is narrow and the walls are enormously thick. These walls are made up of large, globular, glandular cells of various sizes. The cells are separated into groups by trabecula, thus having the appearance of closely packed composite glands. Around this glandular part of the prostate is seen the usual muscular layer. The epithelial cells of the upper chamber are arranged in groups like villi and are fully as large as the epithelial cells of the intestine. The pores of the spermathecæ are postseptal, though opening into the angle of the intersegmental grooves.

There is a pair of racemose sperm-sacs in XII, but instead of projecting from the septum they are seen to grow around the hearts in that somite, the connection with the septum probably having been separated.

The glandular part of the *prostate* is by far the longest, extending to the dorsal part of the somite. The muscular duct is very short and narrow, extending only a little way above the body-wall. Outwardly the glandular part is entire, but sections show it to be composed of numerous separate though closely packed lobes of glandular cells. In the part nearest the lower lumen two distinct layers of cells can be distinguished, but in the upper part there is only one.

In the specimen sectioned, the sperm-ducts on one side of the body fuse together just in front of the pore. On the other side they open through two distinct pores. The sperm-ducts after leaving the funnels dip directly into the body-wall. The testes and ovaries are attached rather high up, or in line with the sperm-funnels.

There is no typhlosole. The sacculated intestine seems to begin in XIII. The nephridia consist of minute tufts of tubules irregularly scattered over the body-wall and especially numerous near the septa. Neither nephrostomes nor nephropores could be found.

Setæ.—The penial setæ are narrower than the ordinary setæ, slightly curved at the apex, and smooth. The ordinary setæ are all ventral and not ornamented. They show the following arrangement according to measurement with the micromillimeter: d–c=30; c–b=40; b–a=13; a–a=35. The distance between the ventral setæ is thus considerably less than that between the lateral setæ.

The body-wall is very thick, the arrangement of the muscular layers being like that in *Notiodrilus*.

Zapotecia, gen. nov.

Definition.—Setæ paired, eight in each somite. Clitellum short. Gizzards three, in V, VI and VII. Meganephridia. Spermathecæ, two pairs in VIII and IX, with imperfect diverticle. No calciferous diverticles of the intestine. Prostates, two pairs, open on somites anterior and posterior to the male pores, which are in XVIII. Penial setæ present. Sperm-ducts hidden in the muscles of the body-wall.

Affinity.—The genus differs from *Trigaster* in the possession of meganephridia instead of plectonephridia. From *Diplocardia* it differs in having three gizzards instead of two.

Zapotecia ameca-mecæ, sp. nov.

PLATE XIV, FIG. 180.

Definition.—Length, 120 mm., width 8 mm. (specimen contracted). Somites 200. Prostomium divides somite I about one-half. First dorsal pore XV/XVI; first large pore XX/XXI. Clitellum saddle-shaped, in XIII–XIX. Setæ all ventral, paired, but not closely so. Penial setæ present at the

prostates, curved and smooth. Genital zone large, square, not deeply sunk. No papillæ or ridges. Gizzards three, in V, VI and VII. No calciferous diverticles. Small subpharyngeal gland. Very small septal glands in VII-IX. Large racemose sperm-sacs in XI and XII, both postseptal, projecting from the septa. Spermathecæ in VIII and IX opening into the intersegmental grooves VII/VIII and VIII/IX, but considerably posterior to the septa. Testes and sperm-funnels in X and XI. Ovaries in XIII. No ovisacs. Sperm-ducts run entirely hidden in the body-wall, fusing at the pore, in XVIII. Prostates in XVII and XIX. One pair of meganephridia in each somite. Nephropores in line with setæ *b*. Last heart in XII. Sacculated intestine commences in XIII. Color pale flesh without any prominent pigment.

Septal formula :—

IV/V, V/VI, VI/VII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Habitat.—Ameca-meca, Mexico. One adult specimen collected by Professor Albert Koebele, in August, 1897, at an altitude of 8,000 feet.

Affinity.—As far as can be judged from Professor Benham's description of his immature specimen of *Trigaster Lankesteri* (Benham, 3), *Z. ameca-mecæ* besides having meganephridia instead of plectonephridia, differs in the location of the three gizzards and of the spermathecal pores. In *Trigaster Lankesteri* these pores are figured by Benham as being in the posterior part of the somite, thus making them preseptal, while in *Zapotecia ameca-mecæ* they are postseptal.

DETAILED DESCRIPTION.

Setæ.—The setæ are paired, but not very closely. By measurement with a micromillimeter ocular the intervals were found to be as follows:—

d–c=35; *c–b*=92; *b–a*=35; *a–a*=115; *a–b*=30; *b–c*=90; *c–d*=35.

The distance between setæ *ab* and *cd* is almost the same.

The *penial setæ*, of which there are two in each sac, are much narrower than the ordinary setæ. A good view of the tips was not obtained, but they appear to be smooth and slightly curved.

Somites.—The segments of the body increase in length gradually towards the front end. The clitellar somites are very narrow. The specimen being in a poor state of

preservation the genital zone is less distinct than it would have been in well preserved specimens. The zone is large but not deep, and is bounded by the edges of the saddle-shaped clitellum, which barely reaches the ventral side of the body. The two longitudinal fossæ could hardly be distinguished.

Gizzards.—The gizzards are fully developed but shorter than in *Trigaster Lankesteri*, as described by Benham. The thick part is situated in the posterior part of the somites. From the thick posterior part the gizzard tapers anteriorly into a very thin wall.

The *tubular intestine* is much nipped by the septa. There are no traces of any calciferous or other diverticles of the intestine and there appears to be no typhlosole. The walls are deeply plicated and strongly vascular.

Glands.—There is a row of narrow but rather long sub-pharyngeal glands opening into the ventral part of the pharynx. This row extends all along the ventral side to the œsophagus. The septal glands are very small and easily overlooked.

Nervous System.—The brain is in somite III. The ventral nerve-cord is very large. Its muscular outer layer is enormously developed, its diameter being thicker than the inner cellular part.

Nephridia.—There is a pair of perfect meganephridia in each somite. The nephropores are in line with setæ *b*. Judging from sections the nephridia seem to resemble those of *Notiodrilus*.

Spermathecæ.—There are two pairs of large spermathecæ in VIII and IX, each possessing a large sac-like diverticle of peculiar structure. This diverticle is directed forwards and is situated in the same somite as the main sac. In one spermatheca the diverticle is formed by the bulging out of the whole anterior wall of the lower, narrower part of the spermatheca; in the other the diverticle is attached to the narrow part of the spermatheca proper, at its junction with the body-wall. The diverticle and the distal sac proper are

of about the same size. The distal sac is of the usual structure, with columnar epithelium. The narrow, lower part of the spermatheca, as well as the diverticle, is of a different structure, the walls consisting of a continuous row of small pockets separated by long, narrow cells. In these pockets are packed bundles of spermatozoa, the heads of which are attached to the bottom wall of the pockets. At the junction of the narrow and the sac-like parts of the main diverticle are found a few cells of the same peculiar, globular form as those found to be so numerous in *Trigaster tolteca*. It is evident that the structure of the lower parts of the spermatheca is similar in *Trigaster Lankesteri* and *Z. ameca-mecæ*, as Benham also describes the spermatozoa as being attached to the lower part of the diverticle. The pores of the spermathecæ are situated half-way between the setæ and the anterior septum, but in the intersegmental grooves. The septa are not connected with the grooves, but are situated much farther forward.

The *sperm-sacs* are very large and extend all around the intestine.

The *testes* and *sperm-funnels* offer nothing characteristic.

The *sperm-ducts* are completely hidden in the longitudinal layer of the body-wall, just as in *T. tolteca*. As Benham did not find any sperm-ducts in *T. Lankesteri*, it is probable that in that species also the sperm-ducts are hidden in the body-wall.

The *prostates* are very thin and folded repeatedly. Their glandular part is many times longer than the muscular duct which appears to be unusually short. The prostates are confined to one somite each, and are composed of two distinct layers of cells.

BENHAMINÆ.

Benhamia *Michaelsen.*

Of the species and varieties described under this genus none equals in interest *Benhamia viridis*. This species seems to be a native of Mexico and not an imported worm.

It is found in the pine region at Toluca, at an altitude of 8,000 feet, and has every indication of being an indigenous form. Its most interesting character is the abnormal position of the sperm-ducts, which makes the species a connecting link between *Benhamia* and *Dichogaster*.

Benhamia Bolavi *Michaelsen*, **pacifica,** var. nov.

PLATE X, FIGS. 68–73.

Definition.—Length 30 mm.; number of somites about 95. First dorsal pore V/VI. Clitellum incomplete, in XIII-XX. Penial setæ, the longer with six sharp-pointed notches, the shorter spoon-like but with no prongs. Common setæ couples equidistant. Oviducts open in a single pore on a median papilla in line between setæ *a*, in center of somite XIV. Gizzards in VIII. Calciferous diverticles, three pairs, in XV, XVI, XVII; the two anterior pairs connected as one. Sperm-sacs in XI and XII. Sperm-masses in X. Micronephridia in three rows on either side. Spermatheca, basal part with small stalked diverticle pointed forwards, apical part much narrower than the basal part. Sacculated intestine begins in XIX. Color pink.

Habitat.—Honolulu, Hawaii. Presented by Mr. Alexander Craw.

Affinity.—This form comes so very near *B. Bolavi* that it seems best to refer to it only as a variety under that species. There are a number of minor differences which appear constant and which are of considerable interest. In order to facilitate a comparison of the three forms of *B. Bolavi* so far recognized, a table is given of the principal differences noted.

TABLE OF *Benhamia Bolavi* AND VARIETIES.

Benhamia Bolavi.	**Benhamia Bolavi,** var. **pacifica.**	**Benhamia Bolavi,** var. **palmicola.**
Length.	*Length.*	*Length.*
40 to 60 mm.	30 mm.	50–60 mm.
Penial Setæ.	*Penial Setæ.*	*Penial Setæ.*
The largest with 5 to 8 notches, the smaller spoon-like, slightly forked.	The largest with 6 spine-like notches, the smaller spoon-like, not forked.	The largest with 4 blunt notches, the smaller spoon-like.
Gizzards.	*Gizzards.*	*Gizzards.*
Situated in VII.	Distinctly in VIII.	Distinctly in VIII.

Calciferous Diverticles.	*Calciferous Diverticles.*	*Calciferous Diverticles.*
Three distinct and separate pairs.	The two anterior ones connected.	The two anterior ones connected.
Spermathecæ.	*Spermathecæ.*	*Spermathecæ.*
The basal and apical parts of about equal width. Diverticle not sessile.	The basal and apical parts of unequal width, apical part much smaller. Diverticle sessile.	The basal part not much wider than the apical part, both globular and of almost equal size. Diverticle sessile, longer than in var. *pacifica*.
Nephridia.	*Nephridia.*	*Nephridia.*
The ventral ones, or 1, are considerably narrower than the lateral ones, and furnished with two separate cœlomic mantles.	The ventral ones, or 1, not much narrower and furnished with only one cœlomic mantle.	The ventral ones, or 1, consist of two unequal parts, each covered with a cœlomic mantle. They are larger than the other nephridia.

DETAILED DESCRIPTION.

Size.—All the specimens are fully mature, with a large clitellum; still none are over 30 mm. in length, while several are less than 20 mm. Variety *pacifica* is therefore the smallest of the *B. Bolavi* group.

Dorsal Pores.—The variety agrees with *B. Bolavi*, but differs from *B. palmicola* in which the most anterior dorsal pore is IV/V.

Penial Setæ.—The smaller seta shows no forking but is distinctly spoon-like. The figure (Eisen 18) of the smaller seta of var. *palmicola* is probably incomplete and figured from a side view, as a side view of the corresponding seta of var. *pacifica* shows a somewhat similar shape; but seen from the face it is distinctly spoon-like (fig. 72). The notches of the larger seta are much more pointed and look like spines, while in var. *palmicola* they are very blunt.

Genital Zone.—The genital zone is not greatly depressed but is rather flat. There is a slight elevation around the prostate pores, and the groove connecting them is curved towards the ventral median line of the body.

Suprapharyngeal Glands.—When seen in a longitudinal section passing through the centre of the body, the posterior lobe is much thicker than the three anterior lobes. There are only four lobes in all, as usual diminishing in size forwards. These lobes are much shorter than in the var. *palmicola*. Small septal glands are present in VIII, IX, X, XI and XII, situated close to the intestine.

Intestine.—The pharynx is furnished with a long dorsal pocket below the suprapharyngeal glands. The sense-organ zone in the palate is much smaller than in var. *palmicola*. In the specimens sectioned the gizzards are short and thick, much more so than in the other varieties. The sacculated intestine commences in XIX, as in var. *palmicola*, but in *B. Bolavi* it commences in XXI.

The *typhlosole* is either very small or absent. In longitudinal sections it did not show distinctly.

The *calciferous diverticles* resemble those of var. *palmicola* in every particular. I have re-examined my sections of the latter form and find that in this, also, the two anterior diverticles on either side are connected in such a manner that they appear as a single diverticle extending through somites XV and XVI. The diverticle in XV does not have a separate connection with the intestine, but is simply an anterior lobe or projection of the diverticle in XVI.

Spermathecæ.—The basal part is much wider than in the other varieties, and the diverticle is more stalked. The size of the basal and apical parts is much greater than in either *B. Bolavi* or the var. *palmicola*.

The *prostates* are upright and the glandular part is folded on itself, reaching down below the beginning of the narrow muscular duct.

The *hearts* are less pronounced and much narrower than in the var. *palmicola*. The last pair is in XIII. The one in XII is much the largest.

The *nephridia* vary considerably but they are always separated and do not overlap or touch each other. Number 2 is generally the largest; it is oblong and round. Number 1 is hardly smaller than 2, and there is no separate cœlomic mantle for the ducts nearest the nephrostome.

Benhamia papillata *Eisen*, hawaiiensis, var. nov.

PLATE X, FIGS. 77-79; PLATE XIV, 170, 171.

Definition.—Length 40 to 50 mm. Somites 114. First dorsal pore IV/V. Prostate pores on small papillæ. Penial setæ largest, with four sharp spines and slightly wider tip; smaller seta with a very thin, slightly sigmoid tip. Diverticle of the spermatheca at the junction of the muscular and glandular part, or in the muscular part. Nephridia in three pairs; No. 1 consists of two lobes of the cœlomic mantle; the ventral lobe is the smallest. Color pale flesh, with yellowish clitellum.

Habitat.—Honolulu, Hawaii. Eight specimens presented by Mr. Alexander Craw. One specimen from Samoa.

The differences between *B. papillata* and the variety *hawaiiensis* while slight are of sufficient interest to warrant their being recorded. It is not necessary to repeat the characters of the species, but only to mention those in which the species and variety differ from each other.

The specimen from Samoa differs in having the diverticle of the spermatheca start from the muscular part instead of from the junction of the glandular and muscular parts, as in the specimens from Hawaii. Unfortunately the penial setæ could not be distinguished in the single specimen from Samoa. I have, however, little hesitation in placing all these forms together in one variety.

EXTERNAL CHARACTERS.—Variety *hawaiiensis* is smaller in size and the somites are fewer in number than in the species. The papillæ on which the prostates open are not as prominent as those of the species. The clitellum is very rough and considerably overlaps the genital pit. The smaller penial setæ are less sigmoidal at the tip, which is somewhat shorter than in the species. The largest seta is furnished with four short spines instead of blunt notches as in the species. The first dorsal pore is VI/V.

INTERNAL CHARACTERS.—The diverticle of the spermatheca joins the latter at the junction of the muscular and glandular part or in the muscular part (specimen from Samoa). In the species the junction is much higher up and on the glandular part. The muscular duct in both the species and the variety is comparatively long. The ventral ganglion in the specimen dissected is greatly enlarged in somite X. Of the constancy of this enlargement I am not certain. The nephridia differ considerably from those of the species. They are shorter and do not extend as far dorsally. The ventral nephridium possesses only two cœlomic mantles, while in the species it has three or four. Two figures (figs. 77 and 81) are given, illustrating their comparative size and form.

Diverticles of the Intestine.—The pair in XVII is the largest, and opens separately into the intestine. The pair in XVI is next in size. The pair in XV is the smallest and being connected with the pair in XVI can only be regarded as a projection of the latter, the two opening through one pore on either side into the intestine.

Benhamia nana *Eisen.*

PLATE X, FIG. 76.

Calciferous Diverticles.—A re-examination of my slides of this species has been made in order to compare its calciferous diverticles with those of the species described in this paper. These glands are shaped very much as are those in *Benhamia Bolavi*, var. *pacifica*, and there is a very small lobe projecting forward from the diverticle in XVI into somite XV. This lobe is connected with the diverticle in XVI by a ciliated duct which joins the ciliated duct of the diverticle in XV, which enters the intestine at the same point as the duct from the diverticle in XVII. The septa from the surrounding somites bunch together at this point and are besides very thin and difficult to separate. The figure of the diverticle of *B. Bolavi*, var. *pacifica*, given in

this paper, would also illustrate the structure of this organ in *B. nana*, provided the anterior lobe was the smaller, instead of *vice versa* as in the above mentioned variety.

I have also re-examined *Benhamia B.*, var. *papillata*, and *Benhamia B.*, var. *palmicola*, and find that even in these forms the two anterior calciferous diverticles are more or less connected and that the posterior diverticle is separated. In var. *papillata* the two anterior diverticles open together into one ciliated tube or fold, while the diverticle in XVII is separated (fig. 76*c*). In *Benhamia nana* the anterior diverticle is very small (fig. 76*d*).

Benhamia viridis, sp. nov.

PLATE XIV, FIGS. 175, 176.

Definition.—Length 110 mm., width 4 mm. Somites 120 to 140. Prostomium divides somite I completely, but the projection is a mere groove or line often extending as far as somite III. Setæ closely paired. Penial setæ present, not ornamented. Anterior dorsal pore XI/XII. Genital zone is a square field formed by two elevated ridges interior to which are two more or less parallel grooves. Six pairs of tubercles in somites XIV–XIX. Spermathecal pores VII/VIII, VIII/IX. Spermiducal pores in the intersegmental groove XVII/XVIII. Prostate pores in the equator of XVII and XIX. Clitellum saddle-shaped, in XIII–XX. Gizzards in V and VI. Calciferous diverticles in XV, XVI and XVII. Sacculated intestine in XVIII. Typhlosole in XVIII and XIX. No sperm-sacs. Spermathecæ in VIII and IX; large apical sac tapering towards the base; a small wart-like, plurilobed diverticle at the base. Hearts in VII–XII. Micronephridia in eight lobes on each side of the median line. Color bright bluish green; clitellum a yellowish brown.

Habitat.—The type is from Toluca, Mexico, at an altitude of 8,000 feet. One other specimen from the City of Mexico. Collected by Professor A. Koebele.

The most interesting character of this *Benhamia* is the position of the spermiducal pores in the intersegmental groove of somites XVII/XVIII, instead of in the equatorial of XVIII as in all the other species. It thus forms a connecting link between the two genera *Benhamia* and *Dichogaster*. If the spermiducal pores in *Benhamia viridis* had been moved forward just one-half of a somite the species would have been a typical *Dichogaster*.

The single specimen from the City of Mexico differs in some interesting particulars from the specimens from Toluca. The ventral part of somite VIII possesses a genital zone consisting of a small rectangular depression surrounded by two parallel ridges which are flanked by two small papillæ, the whole structure occupying the space of the ventral rows of setæ. Sections of this specimen show a pair of prostates situated with the sperm-ducts in somite XVIII. These prostates, which have the same size and shape as those in XVII and XIX, open into the posterior part of the somite, between the equator and the intersegmental groove. The sperm-ducts seem to fuse in somite XVI, opening as is usual in this species into the intersegmental groove between XVII and XVIII. Adjoining these prostates in XVIII are small penial setæ of the same structure as those opening with the regular prostates in XVII and XIX.

It is interesting to note that an exactly similar proliferation of prostates in the somite of the spermiducal pores was found in a specimen of *Trigaster tolteca* previously described in this paper; it is also found constant in some species of *Dichogaster*.

DETAILED DESCRIPTION.

The limited number of specimens and their indifferent preservation makes it impossible to enter as fully into details as could be wished. This refers principally to points of histological interest.

The *prostomium* divides somite I completely, and a deep crease is projected as far backwards as the anterior half of III.

The *somites* are of even size and smooth. Those containing the spermathecæ are, however, furnished with a deep crease on the ventral side on the posterior half of the somite. The genital zone in the most perfect of the specimens consists of a rectangular depression bounded interiorly by the two more or less parallel grooves. Immediately

adjoining these grooves are two elevated ridges, one on either side. Exterior to each of these ridges is a line of papillæ, of which a pair of each is on somites XIV–XIX. Interior to this outer row there are two inner pairs occupying the places of the ventral setæ in somites XV and XVI. These papillæ are absent in some specimens. The spermathecal region in somite VIII is marked by a pair of ventral median papillæ on the anterior half of the somite. The papillæ are situated close together, in line with the ventral setæ.

Setæ.—The ventral setæ as well as the lateral are absent on somite XVIII. The common setæ are strictly paired and all ventral. The tips of the setæ are indistinctly sculptured with small wavy depressions. The penial setæ are short and very slender, about one-third or one-fourth as thick as the ordinary setæ. One seta is straight, of the shape of a knife suddenly contracted at the point. The other is sigmoid and curved at the apex, neither being ornamented exteriorly. Interiorly they are seen to be composed of numerous rings, one following the other as in a coil of wires.

Calciferous Diverticles.—Only the anterior contains lime crystal. The three diverticles open separately into the intestine. There are minute septal glands in VII–XIII.

The *typhlosole* is very small and confined to two somites.

The *clitellum* is not well developed and it is impossible to state whether it is saddle-shaped or ring-like.

The *spermathecæ* consist each of a broad, rather flat spear-head-shaped sac. At the base is a single flat round diverticle with the form of a rosette. Upon closer examination this rosette is seen to be composed of four to ten interior chambers, only slightly set off exteriorly.

The *diverticle* is situated on the anterior side of the septum, while the main sac projects backwards into the posterior somite. The diverticle is about one-third the length of the main sac. There are no sperm-sacs. Sperm-tanks in X and XI.

The *sperm-ducts* fuse and become invested with a strong muscular covering in XVII. They penetrate the septum separating XVII and XVIII at some little distance from the body-wall, and then bend downwards and penetrate the body-wall immediately under the septum in the intersegmental groove of XVII/XVIII. The anterior prostate and bundle of penial setæ, however, open into the equator of somite XVII, while the posterior prostates and setæ open similarly into the equator of XIX. On account of this arrangement the distance between the anterior prostate and the spermiducal pore is only from one-third to one-fourth that between the spermiducal pore and the posterior prostate.

The *anterior prostate* opens immediately behind the penial setæ. The muscular part of the prostate is long and strong. The glandular part is much folded, but confined to one somite. The testes and sperm-funnels in X and XI and the ovaries in XIII are normal.

The body-wall does not contain a row of the sense organs, found in some other species of this genus.

The following septa are thickened, principally in the dorsal parts:

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

The *nephridia* are the most complicated of any which I have observed in this genus. There are about eight rows of sacs on either side of the ventral ganglion, but instead of being regular they vary greatly in size and form, some being almost entire, while others are deeply lobed. The different lobes are more connected than, for example, in *Benhamia Bolavi*, var. *papillata*. The ventral micronephridium is as usual the most compound.

The beautiful color of this species is an unusual one in Oligochæta. Beddard in his large monograph mentions that he has seen a species of *Benhamia* from Trinidad of a bright green color. It is, of course, impossible to say whether Beddard's species is identical with mine, as circumstances did not allow him to describe it.

Benhamia jamaicæ, sp. nov.

PLATE XIV, FIGS. 168, 169.

Definition.—Length 40 mm., width 4 mm. Somites 130. Setæ closely paired, the lateral interval slightly greater than the median. Penial setæ present, smooth with hook-like apex. Male pores in the equator of XVIII. Anterior prostate pores in the posterior part of XVII; posterior prostate pores in the equator of XIX. Prostomium large, divides somite I completely. Somite II larger than those following. First dorsal pore in VI/VII. Clitellum complete but ventrally thin, in XIII-XX. Gizzards two, in VI and VII. Diverticles of the intestine, three pairs in XV, XVI, XVII, not connected with each other and opening independently into the intestine. Sacculated intestine in XIX. Dorsally and ventrally enlarged intestinal epithelium in XXI to XXIV. Suprapharyngeal glands with four tiers of lobes. Septal glands thin but almost continuous from VIII to XIV. Spermathecæ: pores postseptal, VII/VIII, VIII/IX, main sac in VIII and IX, tubular, with a minute, wart-like diverticle at the base and a larger diverticle higher up. Testes in X and XI. Sperm-funnels in X and XI. Sperm-masses in X and XI. Ovaries in XIII. Ovisacs in XIV. Oviducts in XIV. Prostates large and thick, confined to somites XVII to XIX. Sperm-ducts fused, in XVII, a horseshoe-like loop in XVI. Micronephridia, posterior ones, with cœlomic mantles. Color reddish.

Habitat.—Island of Jamaica. One specimen collected by Professor C. H. Tyler-Townsend.

DETAILED DESCRIPTION.

Owing to the want of specimens for dissection, the description of some of the interior organs, especially that of the spermathecæ, is not as full as is desirable.

Somites I, II and III are set off from the balance. Somite III is the largest. The intersegmental groove between I and II is hardly distinguishable.

The common *setæ* are smooth and not characteristic. The larger of the penial setæ is a little more curved than the smaller. The apex of both is furnished with a small close, helix-like hook, which in the larger seta is a trifle more distinct than in the other.

Sense-cells.—There is a zone of hyaline cells with sense-cells in the equator of every somite, also similar cells in the anterior parts of the pharynx.

The *septa* are only very slightly thickened in some places. The septal formula is as follows:—

VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

The *dorsal pores* are large and distinct even to the last somite of the tail.

The *diverticles* of the intestine are large, rounded and oblong, without indentations. Each diverticle opens independently into the intestine and is not connected with the other. The posterior ones are the largest. All are of the same structure, containing no crystals, only lime globules.

The *spermatheca* consists of a main sac, tubular in form and much twisted. There is a small wart-like diverticle at the base of the posterior spermathecæ, but this diverticle is not seen in the anterior pair. In both pairs there is a large diverticle inserted below the centre of the main tubular sac. The diverticle is enlarged at the apex. The apex of the main tubular sac is enlarged, with an outer, irregular outline and with an interior racemose chamber.

The *prostates* are thick and the glandular part is composed of two layers of cells. They open in the equator of their respective somites. The sperm-ducts are fused in XVII and covered with a strong muscular investment. There are no sperm-sacs, only sperm-masses.

The last *hearts* are in XII.

The *genital zone* is rather indifferently preserved in the single specimen. It is square and considerably depressed. In each of the depressed somites is seen an elevated ridge connecting the setæ, but somewhat broken in the median line. The ovipores could not be distinguished.

Benhamia guatemalæ, sp. nov.

PLATE XIV, FIGS. 172–174.

Definition.—Length 40 mm., width 2 mm. Somites 127. Prostomium divides somite I about one-third. Most anterior dorsal pore XII/XIII. Clitellum in XIII-XX. Genital zone a round depression, with four small papillæ

marking the prostate pores. A zone of pellucid cells in the equator of each somite. Setæ paired. Penial setæ present, but not ornamented. Gizzards in V and VI. Tubular intestine ciliated. Diverticles of the intestine in XV, XVI, XVII, each opening independently into the intestine. The two anterior with crystals. Sacculated intestine in XIX. Spermathecæ in VII and VIII; their pores VI/VII, VII/VIII; each with a rosette-like pluri-chambered diverticle near the base. Sperm-sacs racemose, two pairs, in XI and XII. Sperm-masses in X and XI. Testes and funnels in X and XI. Ovaries in XIII. No ovisac. Prostates open in the equator of XVII and XIX. Sperm-ducts open in the equator of XVIII. A dorsal typhlosole beginning in XXVI. Last heart in XII; a trace of septal, but no subpharyngeal glands. Suprapharyngeal glands slender, in four lobes. Micronephridia in five rows on either side.

Septal formula:—

VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—Found in garden soil in the City of Guatemala, Central America.

This species differs from *B. mexicana* in several particulars. The setæ are closely paired and the distance *a–b* is equal to the distance *c–d*. The nephridia are in five rows, while in *B. mexicana* they are in three rows.

DETAILED DESCRIPTION.

The *setæ* are closely paired and the ventral interval is about one-fourth larger than the lateral. The penial setæ are almost straight and their apex is straight, smooth and without ornaments. The prostates terminate on small papillæ.

The *septal glands*, situated close to the intestine in VII–XIII, are hardly perceptible and only one or two cells thick.

The *nephridia* are highly developed micronephridia in all the posterior somites. They are arranged in five rows on each side of the median line. Of these rows the most ventral is the largest. It is also much more branched than the others and occupies the whole lateral interval between setæ *b–c*. Of the remaining micronephridia those in rows 2 and 4 are considerably smaller than those in rows 3 and 5.

There is a *dorsal pore* between XII and XIII but no other anterior dorsal pore. The postclitellar pores begin between XX and XXI.

The *diverticles* of the intestine are not connected with each other, but open independently into the intestine in their respective somites. The posterior pair is the largest, the anterior the smallest. The two anterior pairs contain large crystals. The posterior pair did not contain any secretions.

Spermathecæ.—These organs are large and sac-like, each being furnished with a large rosette-like diverticle containing several pear-shaped chambers strongly marked on the exterior of the diverticle. The diverticle projects through the anterior septum into the somite next anterior to the pore. The pores open into the intersegmental grooves. The specimen sectioned contains an additional spermatheca on one side of the body. It opens into the intersegmental groove between V and VI. It is quite rudimentary. The two main pairs of spermathecæ are in somites VII and VIII.

The *testes* in X and XI, and the two pairs of sperm-funnels in the same somites, offer nothing characteristic. There are two pairs of very minute, racemose *sperm-sacs* in XI and XII, situated on the lateral and ventral sides of the cœlom. The two *sperm-ducts* fuse in XVII, and in XVIII are invested with a muscular coat as thick as the muscular part of the prostates. Both the prostates and the sperm-ducts open into the equator of their respective somites.

Dichogaster *Beddard*.

General Remarks on Affinity.

The three new species which I am enabled to describe tend to further cement together the various species of this genus, as well as to confirm the views held by Dr. Michaelsen in regard to the affinity of the genus. He explains the striking similarity between some species of *Benhamia* and

Dichogaster by supposing that the latter genus has descended from the former through a process of reduction of the prostates and through a displacement of the male pore. That such reduction and displacement has actually taken place is evident from the fact that some of the species now described offer characteristics which are intermediate between the two genera. A perfect series is had from the typical *Benhamia* with its male pores in the equator of XVIII to the typical *Dichogaster* with its male pores opening with the prostates in the equator of XVII.

Benhamia viridis forms the first link in this chain. In this species the pore of the sperm-ducts has advanced more than one quarter of a somite, being found in the anterior part of XVIII near the intersegmental groove. The next link is seen in *Dichogaster Ribaucourti*, where we find the pore of the sperm-ducts in the intersegmental groove between XVII and XVIII. In this species the prostates have remained. The next link is *Dichogaster Townsendi*, in which the pore of the sperm-ducts is in the equator of XVII, together with the prostate pore, but the remains of the former spermiducal somite are yet recognizable in an accessory septum found in somite XVII. This accessory septum is situated immediately posterior to the sperm-ducts, lying between them and the septum separating somite XVII from the fully developed somite next posteriorly. As might be expected, somite XVII is slightly larger than either of the adjoining somites, but otherwise there is no exterior sign that two somites have been fused together.

The development of *Dichogaster* from its *Benhamia*-like ancestors has thus comprised two distinct processes: one consisting of a displacement of the male pore forward, the other in a reduction in size and the disappearance in part of the male pore-bearing somite, XVIII.

As regards the reduction of the prostates, we find this to be more or less complete and not subjected to any general rule. While in some species the prostates have disappeared from the somites posterior to the male pores, in others they

have remained, and in some species—*D. Townsendi* and *D. Damonis*—an increase in the number of prostates has taken place.

It is superfluous to state that the author fully agrees with Dr. Michaelsen's theory of the derivation of *Dichogaster* from ancestral *Benhamias;* also in the derivation of Cryptodrilini from Acanthodrilide ancestors. It is impossible with our present knowledge of the structure of the various species of *Dichogaster* and *Benhamia* to keep the families separate as proposed by Beddard.

It may be of some interest to recapitulate and review the similarities between the genera *Benhamia* and *Dichogaster*. These similarities are so many and so important that they can not possibly be accounted for by chance. The following characters are found in some of the species of both genera:—

1. A pellucid zone of sense-cells in the pharyngeal region.
2. A zone of sense-cells in the equator of each somite.
3. Micronephridia covered with a cœlomic mantle.
4. A great variation in the nephridia in the different species.
5. Intestinal posterior cœca *(Millsonia* and *Benhamia cœcifera)*.
6. A very characteristic arrangement and structure of calciferous diverticles in XV, XVI and XVII.
7. The form of the spermathecæ.
8. A depressed genital zone, below the general surface of the body.
9. Two forward gizzards.
10. A tendency to variation in the position of the spermiducal pore.

In the following, Dr. Michaelsen's view as to the limits of the genus has been accepted to the extent of placing in it the genus *Millsonia;* but in addition, in concurrence with the suggestion of Beddard, the genus *Microdrilus* has also been included. This I know will clash with Dr. Michaelsen's view as to the reduction of the prostates and their

relation to the spermathecæ. Dr. Michaelsen holds that the reduction of the posterior prostates and the forward movement of the sperm-ducts has been necessarily accompanied by a reduction of the *anterior* pair of spermathecæ. So far as we know, this has been the case in four only of the *Dichogaster* species, *Dichogaster Damonis*, for instance, being an exception.

On examination, *D. Townsendi* is found to greatly resemble *D. Damonis* in almost every particular, except that the former possesses two pairs of spermathecæ. It is impossible to separate these two species and refer them to different genera. Among the other species, *Microdrilus saliens* differs from *D. Braunsi* principally in the possession of two pair of spermathecæ, but in other respects the reduction of the prostates and the forward movement of the sperm-ducts have been completed. In another species, *D. Ribaucourti*, the forward movement of the sperm-ducts has alone been accomplished, the two pairs of prostates and the two pairs of spermathecæ remaining.

As the genus *Dichogaster* is now presented, it is impossible to segregate any one of the species without destroying the whole genus. If, for instance, we begin by assigning *D. Ribaucourti* to the genus *Benhamia*, on account of its two pairs of prostates and its two pairs of spermathecæ, then we must, to be consistent, refer *D. Townsendi* also to this genus; but if *D. Townsendi* is placed in the genus *Benhamia*, *D. Damonis* must likewise be placed there, as these two species differ only in the presence or absence of the anterior pair of spermathecæ. Similarly, if we transfer *D. saliens* and *D. Crawi* to the genus *Microdrilus*, then, also, must be referred to this genus several other species which do not possess posterior prostates.

As will be seen from the above, it is impossible to segregate any of the species and place them in other genera without destroying the whole genus. At the same time, we see that the most constant character is the position of the sperm-ducts in the center of somite XVII; but even this constancy of character is shaken by the position of the

sperm-ducts in the intersegmental groove in *D. Ribaucourti*. It may further be seen that the reduction of the prostates is often but not always accompanied by a corresponding reduction in the anterior pair of spermathecæ. In one species the anterior pair of spermathecæ has been reduced but the prostates have been increased.

In *D. Damonis*, for which species the genus *Dichogaster* was created by Beddard, the only pair of spermathecæ is found in somite VIII and not in IX, the reduction in this species having taken place in the posterior pair of spermathecæ and not in the anterior pair. Under these circumstances, the validity of the theory advocated by Dr. Michaelsen, that the reduction of the posterior prostates is accompanied by a reduction of the anterior spermathecæ, is questionable. Should we eliminate from the genus *Dichogaster* any species with spermathecæ in somite VIII, then we would have to drop from the genus the very species for which the genus was created.

Since the above was written, the author has received from Dr. Michaelsen his interesting paper on *Balanta* (29). In this paper Dr. Michaelsen enlarges yet further upon his views in regard to the reduction of the anterior spermathecæ and the posterior prostates. If we consider all the known species of *Dichogaster*, it will be seen that the theory does not hold good in all instances, and cannot, therefore, be considered of universal importance. The accompanying diagram, arranged in accordance with that constructed by Dr. Michaelsen, will, I think, show the variations in the reduction of the prostates and spermathecæ. Here it will be seen that while in *Dichogaster Crawi* the posterior prostates have been reduced, the anterior and corresponding spermathecæ remain; and also that although the posterior spermathecæ have been eliminated in *D. Damonis*, the anterior prostates still remain. Moreover, the diagram shows that while in some species the sperm-ducts have been moved forward, no corresponding elimination of prostates and spermathecæ has taken place. In order to make the diagram more useful I have included the gizzards and diverticles and also endeavored to show the three kinds of nephridia. The diagram of *D. nigra* will serve also for *D. mimus*, *D. Braunsi* and *D. Hupferi*. In *D. mimus* the sperm-sacs are in XI and XII. In the other two species they are unknown.

KEY TO THE SPECIES OF *Dichogaster*.

I. Two pairs of spermathecæ.
   1. One pair of prostates in XVII. Somite I reduced. Penial setæ present ..... *D. Crawi*, sp. nov.
   2. One pair of prostates in XII. Somite I normal. Penial setæ present ..... *D. saliens* BEDDARD.
   3. Two pairs of prostates in XVII and XIX. No penial setæ. Male pores in the intersegmental groove, but in XVII. *D. Ribaucourti*, sp. nov.
   4. Three pairs of prostates in XVII, XVIII and XIX. No penial setæ. Male pore in the equator of XVII. *D. Townsendi*, sp. nov.

II. One pair of spermathecæ. No penial setæ.
   5. Three pairs of prostates in XVII, XVIII and XIX. A wart-like spermathecal diverticle. Spermathecal pores VII/VIII. *D. Damonis* BEDDARD.
   6. One pair of prostates in XVII. Male pores open in a copulatory bursa. Spermathecal pores VIII/IX. No spermathecal diverticle ..... *D. nigra* BEDDARD.
   7. One pair of prostates in XVII. Male pores separated. Spermathecal pores VIII/IX. A wart-like spermathecal diverticle. *D. mimus* MICHAELSEN (10).

III. One pair of spermathecæ. Penial setæ present; one pair of prostates in XVII.
   8. Differentiated spermathecal sexual setæ. *D. Hupferi* MICHAELSEN (6).
   9. No differentiated spermathecal sexual setæ. *D. Braunsi* MICHAELSEN (18).

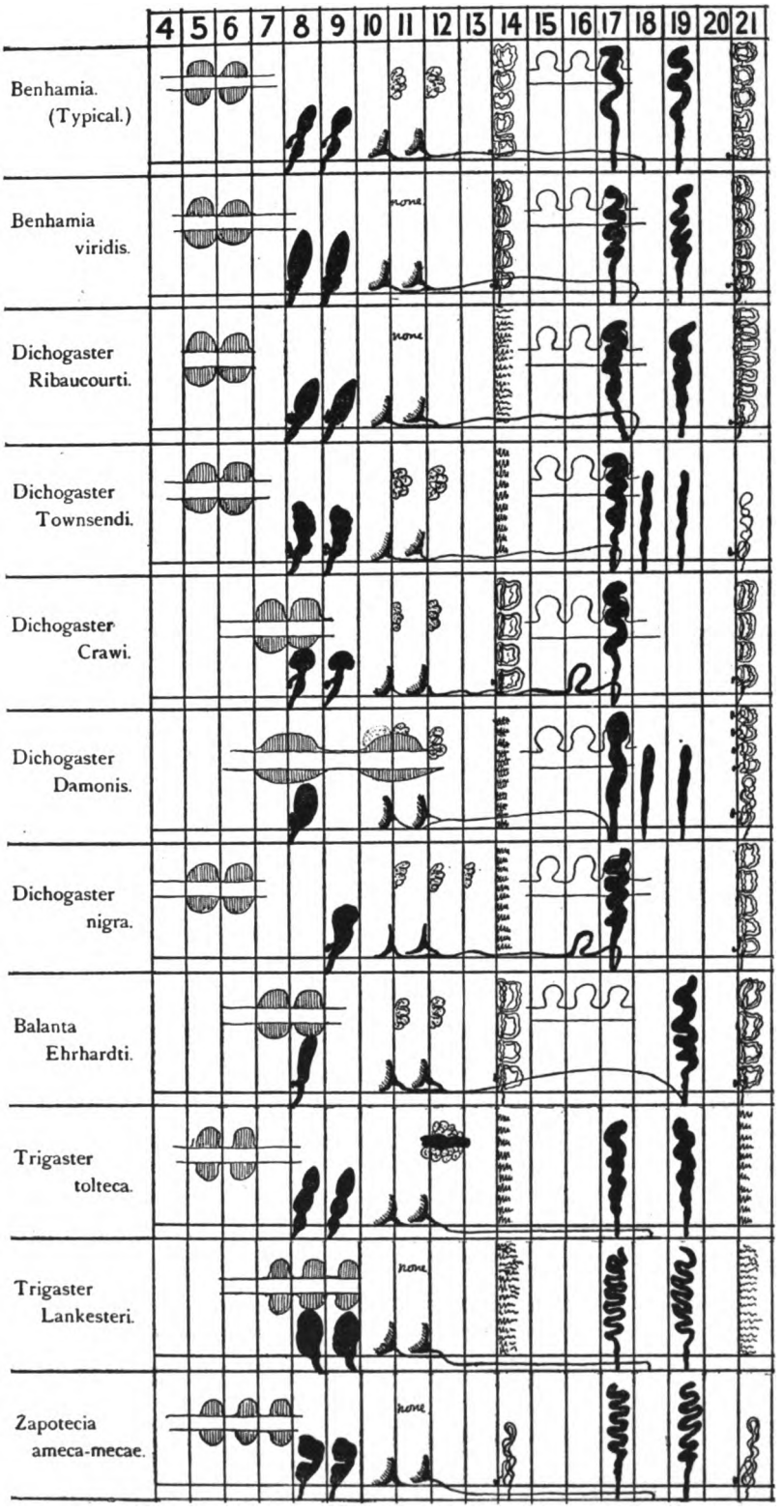


DIAGRAM SHOWING LOCATION OF GIZZARD, SPERMATHECÆ, SPERM-SACS, PROSTATES, SPERM-DUCTS, DIVERTICLES AND THE NATURE OF THE NEPHRIDIA.

Dichogaster Crawi, sp. nov.

PLATE VI, FIGS. 82–94B, 112, 113.

Definition.—Length 40 mm. Somites 120. Prostomium and somite I are reduced. Clitellum complete, in ½ XIII–½ XX. Genital zone sunk, narrow, from XVI–XVIII. Male pore on papillæ in XVII, in line with setæ *ab*. Setæ strictly paired, faintly ornamented. Setæ *ab* absent in XVII. Penial setæ straight with seven knees on each side. Dorsal pores begin III/IV. Spermathecal pores VII/VIII, VIII/IX, in front of setæ *ab*. Testes in X and XI. Ovaries in XIII. Racemose sperm-sacs in XI and XII, postseptal. Ovisacs, one pair in XIV. Oviducts in XIV, opening into separate pores, situated close to and interior to setæ *ab*. Gizzards two, in VII and VIII. Tubular intestine begins in XII. Sacculated intestine begins in XIX. Typhlosole large, commences in XXIII, zigzags on dorsal side. Calciferous diverticles in XV, XVI, XVII, with one duct in XVI. Last heart in XIV. Prostates confined to somite XVII. Sperm-ducts open immediately behind prostates in the same papilla. Micronephridia in four rows on each side of the median line.

Habitat.—Honolulu, Hawaii. Found among the roots of plants received at San Francisco. Collected and presented by Mr. Alexander Craw, State Horticultural Quarantine Officer of California, after whom I take pleasure in naming the species. One specimen was also received from the plant-house at Del Monte, California, taken in June, 1897. The worms when alive showed great activity, jumping several inches into the air when touched.

The specimen from Del Monte differed from the Hawaiian specimens in the disposition of the nephridia and in having a little longer spermathecæ. *Dichogaster Crawi* is nearest related to *Dichogaster saliens*. Judging from Beddard's rather short description, the two species differ from each other in the following particulars:—

Dichogaster Crawi.	*Dichogaster saliens.*
Somite I reduced.	Somite I normal.
Penial setæ with a fine hair tip furnished with a knob.	Penial setæ without fine hair tip.
The posterior calciferous diverticle connected by a ciliated duct with the duct of the anterior diverticle.	The posterior calciferous diverticle connected with the upper part of the anterior diverticle, and without any ciliated duct.

EXTERNAL CHARACTERS.

Somites.—The prostomium (fig. 84) is very small and causes only a small indentation in somite I, which is the narrowest, being about one-third the width of II. The somites following increase slightly in width up to somite VI and VII, both of which are of equal size, and about twice as wide as I. Somites VIII to XII gradually decrease in size towards the clitellum, which commences in the center of XII and continues to the center of XIX. The somites posterior to the clitellum are much narrower but more distinctly three-ringed. Somite I is narrowest on the ventral side.

Dorsal pores.—First pore III/IV. The first very distinct pore, viewed exteriorly, is V/VI.

Setæ.—The setæ are strictly paired and ventral, not reaching the lateral line. The couples are nearly equidistant from each other, except in the somites where a deltoid arrangement is found, similar to that which is seen in some species of *Microscolex (Deltania)*. The distance *a–a* increases from about somite XXVIII to XVII, in which is the male pore; and from XVII the distance increases forwards to somite XI, then decreases towards VIII and VII, the spermathecal somites. From VII forwards there is first a slight increase, then a narrowing towards I.

All the setæ are slightly sigmoid, with four or more slight notches or spines near the apex. There are two bunches of penial setæ in XVII, at each male pore. The projecting part of the setæ is either slightly curved or perfectly straight, tapering to a fine point, which is bent in a right angle and furnished with a knob. The outline is strongly wavy, showing about seven sharp knees on either side, but with no other ornamentation. The smaller seta has the knees less prominent and the bent apex longer, and the knob fully as large as that of the larger seta. The third seta appears to be undeveloped. In one sac this seta was very strongly curved.

Genital Zone.—(fig. 83.) This zone is small but distinct. It commences with somite XVI and ends with somite XVIII. It is very narrow, of about the width of a somite, except in the centre, where it is about twice as wide. The whole zone is sunk as in *Benhamia* and surrounded by an elevated ridge of clitellar cells. There are no distinct markings of the somites in the zone, except at the boundaries. There are two male papillæ in the centre of the zone, from each one of which protrudes the large, almost straight apex of a penial seta.

Lymphocytes and Cells of the Body-wall.—(figs. 91, 113.) The prostomium is well developed and its epithelial cells are taller than the cells of the nearest somites, tapering towards the interior and ending in a fine hair-point. Such cells are also, though more sparingly, found in the epidermis of the other somites, interspersed among ordinary supporting cells. They stain differently from the latter, being more erythophile, while the supporting cells are decidedly cyanophile. In the former pages of this paper it has been pointed out that similar cells are found in large numbers in the caudal zone of *Pontoscolex*, and it is stated as my opinion that they are probably sense-cells, especially responding to vibrations transmitted through the soil.

On the inner side of the prostomium, but especially on the two inner lips or ridges separating the mouth from the palate, we find groups of regular taste-cells, each with a fine hair-point. They occur in bunches of twenty or more, and the hair-points frequently project through the cuticle in such numbers as to give the cells the appearance of being ciliated. These cells stain much deeper than the other sense-cells. They have the same general form.

Dr. R. Hesse in a most admirable paper (2) has described a number of cells of very distinct construction, which he supposes, and as it appears with very good reason, to be cells sensitive to light. Cells of a similar nature are found in considerable numbers in the prostomium of *Dichogaster Crawi*. Their structure is similar to that of the light-cells of *Allolobophora arborea*, as figured by Hesse. They vary

in size and shape, but the central core in the cytoplasm is always rounded or ovoid. The cytoplasm of the core (fig. 113) is always coarsely vacuoled or foam-like, while that outside of the core is much more finely granulated. The distinction between the two is always great and well marked, the central core staining paler than the surrounding cytoplasm. The best differentiation was effected with eosin and thionin. With hæmatoxylin the foamy structure of the cytoplasm becomes clouded and indistinct.

These light-cells were not found outside of the prostomium. There were none in the brain or in other ganglia. Beddard described in *Microdrilus saliens* a zone of clear cells in the pharynx, similar to the corresponding zone in *Benhamia*, and he calls attention to the astonishing resemblance between these two genera in this respect. In *Dichogaster* such a zone exists in the two circular lips or ridges of the mouth, next to the prostomium, but it is less well defined than in *Benhamia*, common supporting cells appearing between the clear cells. At one end of this zone there is an area consisting of glandular cells. In the central median line of each somite there is a continuous row of glandular cells, six to ten cells deep, staining more intensely than the regular goblet cells of the epidermis. In the center are a few sense-cells, but as far as I can see with no sense-hairs. This zone resembles the sense-zone found in the equator of the somites of *Benhamia*, but it is less differentiated and defined.

Mucocytes.—(fig. 12.) There are several kinds of lymphocytes in the cœlomic cavity. The large majority consist of very large mucocytes, each with a nearly central nucleus and foam-like cytoplasm, radiating towards the nucleus. These call for no special description.

Morocytes.—This name is proposed for a certain kind of lymphocyte with peculiar characteristics. The nucleus is nearly always situated close to the cell-wall. The cytoplasm is separated into two distinct parts. One of these is central, extending from one end of the cell to the other;

this part is generally sausage-like, curved or rounded, and appears quite solid. One of its long ends touches the nucleus while the other reaches the cell-wall on the opposite side. This large central body is connected by a few very thin cytoplasmic strands with the cell-periphery. It is composed of a number of hyaline globules of various sizes, around which the cytoplasm is crowded. The central cytoplasmic core resembles a mulberry; hence the name.

Eosinophiles.—These cells are small and round, of the same size as the morocytes, but less numerous. The diameter of the nucleus, which is frequently slightly polymorphous, is twice the diameter of the morocyte. The cytoplasm is coarse and fills the cell outside of the nucleus.

INTERNAL CHARACTERS.

Septa.—Some of the septa are slightly thickened. The most anterior thickened septum is that separating somites IV and V; it passes behind the suprapharyngeal glands. This septum is quite as thick as the longitudinal muscular layer of the body-wall. There is an exceedingly thin strand separating V and VI. Posterior to this there are no distinct septa until VIII/IX. The following septa are all very thin, but XI/XII, XII/XIII, XIII/XIV are thickened, principally nearest the body-wall on the dorsal side. The last three septa mentioned are as thick as the muscular layer of the body-wall. The septum separating XI and XII is connected by muscular straps with the posterior parietes on the dorsal side. This structure has been described by Beddard as also belonging to *Dichogaster rubens* and *D. nigra*, though occurring in different somites in those species.

The specimen of *Dichogaster Crawi* which I sectioned longitudinally is peculiar in that each of somites XI and XII has two septa, one at a little distance from the other and running somewhat irregularly. The septum X/XI corresponds to the intersegmental groove X/XI. In septum XI/XII, the anterior part is situated in the center of XI, the posterior part in the intersegmental groove XI/XII; there is

also a septum extending from the posterior intersegmental groove on the ventral side of XII to the center of the dorsal side of XII. The formula for the septa would be as follows:

$\overline{IV/V}$, V/VI, O, O, O, O, X/XI, $\overline{XI/XII}$, $\overline{XII/XIII}$, $\overline{XIII/XIV}$, disregarding the double septa in XI and XII, the constancy of which is not proven.

Intestine.—(fig. 91.) The prostomium is quite large and furnished with an epithelium much wider than that of the body-wall, consisting almost exclusively of taste-cells interspersed with a few light-cells. At the inner base of the prostomium there runs all around the mouth the usual pair of lip-valves capable of closing the intestinal tract against the exterior. Between the lips and the pharynx there is a space as wide as the lips themselves, occupied by a common epithelium. The pharynx is developed only dorsally and is sac-like. The pharyngeal glands are large, especially the posterior lobe. The anterior lobes are hardly perceptible in longitudinal median sections. In slightly extra-median sections we see that the anterior lobes are present, but small. There are five lobes, respectively diminishing in size forwards, but the anterior lobe is very much smaller than the one next to it—so small that it readily escapes observation.

The *œsophagus* extends a considerable distance behind the pharynx. It is at first narrow, widening out to about three times the original width and then joining the gizzards.

The *gizzards* are in VII and VIII, joined by a narrow bridge. Behind the gizzards the intestinal walls are furnished with a thick, folded epithelium extending through somites IX–XII inclusive. In XIII the intestine becomes tubular, the epithelium not being folded and the walls being narrow. This part of the intestine is perfectly straight throughout, there being no bend either before or behind the gizzards.

Calciferous Diverticles.—(figs. 92, 93.) There are three pairs, the same as in *Benhamia*, and they are of the same general structure. There is only one entrance from the

diverticles, on either side, to the intestine. This entrance is situated on the dorsal side of the intestine, just below the septum XV/XVI. But the connection between the diverticles on each side is not such as is figured by Beddard in his *Microdrilus saliens*. There we see that the connection is high up and the posterior diverticle appears to be merely a fold or projection of the middle one. In *Dichogaster Crawi* the posterior diverticle is connected with the main duct by a long duct which runs parallel to the intestinal wall. The anterior pair of diverticles is in reality only lobes of the second pair, and only slightly set off from it. The posterior pair is well set off from the middle pair.

Sexual Apparatus.—(figs. 89, 94.) As far as can be judged from Beddard's descriptions, these organs resemble those of *Microdrilus saliens*. The two pairs of spermathecæ are of toadstool shape, each with a short diverticle pointing forwards. The ciliated sperm-funnels are short, compact, and not folded, much the same as in *Benhamia*. The sperm-sacs are small, racemose, and postseptal in XI and XII. The ovaries in XIII are just inside of the clitellum. There are two ovisacs protruding from the septum XIII/XIV into XIV.

The *sperm-ducts* are separate till they reach the pore. With the commencement of somite XV they are comparatively narrow, but in that somite their muscular layer begins to widen and at the end of it is more than twice as thick as in XIV. From somite XIV to the pore the combined ducts are of even thickness, and as wide as the muscular duct of the prostate. The sperm-duct at this point is as thick as the two muscular layers of the body-wall combined. It lies entirely free and on the top of the cœlomic epithelium.

The *prostate* is tubular and confined to one somite, XVII. The muscular part is quite long. The glandular part is tubular and consists of two layers of cells. The papilla on which the pores are situated is strongly convex, but hardly extends above the line of the general body-wall. The prostate opens in the centre of the papilla, and the sperm-duct immediately behind in the posterior part of the pore.

The *oviducts* open separately, each one on a papilla occupying the whole width of the somite. The cells of this papilla are very thin and stain less deeply than the clitellar cells.

Nephridia.—(fig. 90.) The nephridia are strikingly like those of a *Benhamia*. There are only micronephridia arranged in four rows on each side, extending from the ventral to the dorsal side, almost uniting with each other at the dorsal line of the body. Each one of the four micronephridia consists of a cœlomic rounded mantle, with ducts along its anterior margin. Nephridium 1 consists of one larger and two smaller mantles, the latter covering part of the ducts nearest the nephrostome. I could only find nephrostome belonging to nephridia 1; they are in line with setæ *ab*. There is a pair of peptonephridia in somite IV. In the specimens from Hawaii the nephridia are arranged as in fig. 90. In the specimen from Del Monte the fourth and most dorsal nephridium is situated much nearer the dorsal line, there being a space between the third and fourth nephridium as wide or wider than the largest micronephridium.

Vascular System.—The last hearts or connecting vessels are in XII. Commencing with XIV the dorsal vessel is greatly enlarged, forming out of the main median trunk a large median heart separated from the one in somite XIII by valves. The corresponding enlargement in XIII is almost as large, but the one in XII is several times smaller, and hardly larger than the normal size of the vessel. A similar enlargement of the dorsal vessel has been described by Beddard in *Millsonia rubens*.

Dichogaster Ribaucourti, sp. nov.

PLATE XIV, FIG. 181.

Definition.—Length 80 to 100 mm., width 3 mm. Somites 150. Prostomium very narrow, divides somite I completely. No dorsal pores anterior to clitellum. Genital zone consists of two elevated crescent ridges, with the concavity ventral, in somites XVII to XIX. Setæ strictly paired. No penial

setæ. Sperm-ducts straight, joining in XVII, opening into the intersegmental groove between XVII and XVIII. Prostates, two pairs; the anterior pair opens immediately ventral to the sperm-ducts in XVII, the posterior pair opens in the center of XIX. Spermathecæ, two pairs; one pair in VIII, one pair in IX, their pores in line with setæ *ab* in the intersegmental grooves between VII/VIII, VIII/IX; several diverticles near the base. Oviducts separate. Sacculated intestine commences in XIX. No typhlosole. No intestinal cœca. Gizzards, two in V and VI. Calciferous diverticles. three pairs in XV, XVI, XVII, opening into the intestine through three pairs of pores. Last hearts in XIII. Nephridia are micronephridia, ten on each side, each one with a cœlomic mantle. Testes and sperm-funnels in X and XI. Ovaries in XIII. Color reddish brown, pigmented, strongly iridescent on dorsal side.

The following septa are thickened:—

VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—City of Mexico, Mexico. Collected by Professor Albert Koebele, September, 1897. Five specimens preserved in formalin, only three of which possess an exterior genital zone. The clitellum is not differentiated in any of the specimens.

Every species of this interesting genus proves conclusively that the genus cannot be far removed from *Benhamia*, and that with Michaelsen we must consider *Dichogaster* as a reduced *Benhamia*. The present species demonstrates also that this genus is not as incongruous as Beddard supposes, and that the species with separate prostates posterior to the male pores are not sufficiently distinct to warrant assigning them to a separate genus. In the species under consideration one pair of accessory prostates is found in XIX, making the species intermediate between those species without accessory prostates and those with three accessory pairs (*D. Damonis* and *D. Townsendi*).

DETAILED DESCRIPTION.

The *prostomium* is exceedingly narrow, the posterior projection being merely a furrow completely dividing somite I. The somites offer nothing especially characteristic. The clitellum is not developed in any of the five specimens, but there is no reason to suppose that it is wanting in fully mature individuals.

The *genital zone*, on account of the absence of a clitellum, is less developed than in fully matured specimens. The two lunate ridges covering the three somites XVII to XIX are of even thickness throughout their length, and so curved that they enclose between them a zone oval in the center. The specimens not being in the very best condition, it was impossible to observe any of the exterior pores.

The *setæ* are strictly paired and all ventral. Their tips are slightly scalloped. The absence of penial setæ brings this species into close relation with *Dichogaster Damonis*, which species it also resembles on account of its accessory prostates.

The *sperm-ducts* are straight, without the horseshoe-like bend found in *D. Crawi*. The two sperm-ducts are separate until they reach somite XVII, where they fuse into one just before entering the male pore, which is intersegmental and not equatorial.

The absence of *sperm-sacs* may be due to the immature state of the specimens.

The *sperm-funnels* lie immediately behind the testes in X and XI. In line with the testes, but in somite XII, is found a pair of structures resembling ovaries. They are somewhat smaller than the regular ovaries in XIII and less divided than the testes. These structures are probably accidental.

The *prostates* have the normal structure. There is a long muscular duct and a thicker glandular upper part. The latter, which is confined to one somite, contains two layers of cells, the inner of which is very minute.

There are no ovisacs developed. The spermathecæ are large and sac-like, pointing forward. There are several small wart-like diverticles pointing forward and penetrating the anterior septum, the diverticles thus being on one side of the septum, while the main sac is on the other. The pores are in the intersegmental grooves.

The *calciferous diverticles* are arranged three on each side. The two anterior pairs contain lime crystals. The posterior pair is of a different structure, the inner lining consisting of globular cells like those figured from *Benhamia nana*. In this posterior pair there are no lime crystals. Each diverticle opens into the intestine by a separate pore, and they bear no relation to each other. There is no typhlosole and there are no intestinal cœca.

The *nephridia* resemble in a general way those of the genus *Benhamia*. There are ten rows of micronephridia on either side of the ventral ganglion. The pair nearest the ganglion is split up into three small lobes, and the one nearest this consists of two lobes, but all the others consist of but a single lobe. Each lobe is surrounded by a cœlomic glandular mantle. No nephrostomes were observed. There is no specialized zone of sense-organs in the epidermis.

Dichogaster Townsendi, sp. nov.

PLATE XIV, FIG. 182.

Definition.—Length 90 mm., width 5 mm. Somites about 165. Prostomium divides somite I about one-half. Dorsal pores present. Genital zone, a flat, square field on the ventral side of XVI–XIX (immature specimen). Setæ paired, absent on somites XVI and XVII. No specialized penial setæ. Spermathecæ two pairs, in VIII and IX; pores postseptal; a medium sized diverticle pointing forwards. Testes, two pairs in X and XI. Sperm-funnels in X and XI. Sperm-sacs racemose, in XI and XII, both postseptal. Three pairs of prostates. Anterior prostates opening with the sperm-ducts into XVII, one pair in XVIII and one pair in XIX. Two gizzards in V and VI. Diverticles of the intestine in XV, XVI, XVII. Sacculated intestine commences in XIX. Last hearts in XII. Nephridia: anteriorly plectonephridia, posteriorly meganephridia. No subpharyngeal glands and no septal glands. Color, above brownish and pigmented, below pale, uncolored.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, $\overline{\text{X/XI}}$, $\overline{\overline{\text{XI/XII}}}$, $\overline{\overline{\text{XII/XIII}}}$, $\overline{\overline{\text{XIII/XIV}}}$, $\overline{\overline{\text{XIV/XV}}}$, XV/XVI.

Habitat.—Jamaica. Collected by Professor C. H. Tyler-Townsend, for whom the species is named.

This species is readily distinguished by its two pairs of spermathecæ and three pairs of prostates, as well as by the absence of specialized penial setæ. The arrangement of the nephridia is also characteristic. The male pore is equatorial, while, in *D. Ribaucourti* it is intersegmental.

DETAILED DESCRIPTION.

The single specimen at my disposal was poorly preserved in alcohol and contained much sand. It was first halved and washed free from sand, after which one half was sectioned lengthwise. The specimen is not adult and the clitellum is not indicated. All other organs were, however, fully developed, with perhaps the exception of the prostates, mention of which will be made later.

Somites.—The prostomium and somite I are small but normal. From somite XI anteriorly the somites are much smaller. Somite XVII is somewhat larger than those adjoining.

Setæ.—The common setæ are rather slender and straight and without ornamentation. There are no setæ *ab* in XVII and XVIII, but there is at least one seta at the prostate pores in XIX. These setæ are possibly a trifle more slender than the ordinary ones but cannot be considered as penial setæ. All the setæ are closely paired and all ventral. The ventral interval is one-third greater than the interval *b–c*.

Septa.—The septa are remarkable for their thinness. In no other earthworm have I found the septa so thin, most of them being only one or two strands thick. The thickened septa are thickened principally along the dorsal and ventral sides. There is no trace of septal glands nor of any subpharyngeal glands, but the suprapharyngeal glands are fully developed.

Intestine.—The two gizzards are powerfully developed and are not particularly characteristic. The tubular intestine is straight. In somites XV to XVI there are as usual

three pairs of diverticles, which in this species are much developed. Each diverticle opens independently into the intestine.

Spermathecæ.—The spermathecæ are of large size, each one consisting of a large distal sac and a narrower duct. The pores are in the anterior part of the somite and accordingly postseptal. They open into the intersegmental grooves of VII/VIII and VIII/IX. I am unable to state whether the diverticle penetrates the anterior septum. The upper sac-like part has a remarkably thin wall, as thin as the thinnest septum and entirely without columnar epithelium. The muscular duct, however, is thick and furnished with a somewhat pear-shaped diverticle containing from three to several longitudinal chambers which seem to open separately into the muscular duct.

The *testes* and *ovaries* are minutely lobate.

The *sperm-sacs* are strongly racemose. The *sperm-ducts* run side by side but do not fuse until they reach somite XVII. Here the duct is seen to be strongly muscular and as wide as the prostate, behind which it passes, opening into the same pore. Of the three pairs of *prostates*, the anterior pair, which opens with the sperm-ducts, is the largest, being of the usual size. It is confined to somite XVII. The upper, glandular part is no thicker than the muscular part and has no distinct glandular cells, though there are two distinct layers of cells. The outer cells are very minute, resembling connective tissue. This unusual structure of the prostate may be due to degeneration. The prostates in XVIII and XIX are about one-half as wide as those in XVII. They open into the equator of their respective somites. The one in XIX opens immediately in front of a common setæ. These posterior prostates are present on both sides of the worm and possibly are characteristic of the species and not accidental proliferations.

Nephridia.—The nephridia of this species are interesting. There are no micronephridia, as in some other species, at least none covered with a cœlomic mantle. Anterior to the clitellum the nephridia show a plectonephric condition,

as in most other species; but posteriorly, where it would be expected that micronephridia would be found, are large and apparently typical meganephridia. Typical is used advisedly, as the condition of the specimen did not allow of any very minute investigation.

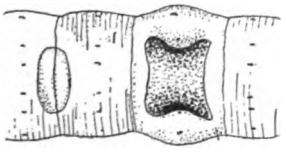
PERICHÆTINÆ.

Pontodrilus *Perrier.*

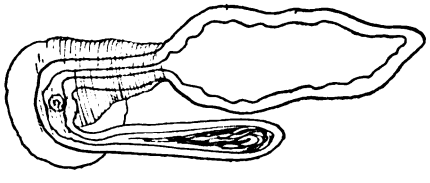
Pontodrilus Michaelseni *Eisen*, hortensis, var. nov.

Definition. — Length 75 mm., width 3 mm. Prostomium encroaches slightly on somite I. Setæ with exceedingly faint transverse furrows. Sexual zone depressed, with two parallel pits separated by a slight longitudinal ridge. Anterior to this zone the clitellum is saddle-shaped. Spermathecæ large, pear-shaped, with narrow duct and a narrow, club-shaped diverticle. Prostate with the muscular duct about two-thirds as wide as the glandular part. The sperm-duct enters the glandular part near the muscular part and enters the lumen at once. Intestine with a vascular crop in XIV and XV which is strongly contracted at the septa. In other respects similar to the species.

Habitat.—In garden soil, along sewers in the gardens of Loreto, Baja California, Mexico, June 20, 1899. Many specimens fully adult and with well developed clitellum and sexual zone. The soil in the gardens is slightly saline, but not to such an extent as to prevent the cultivation of oranges, limes and bananas. The date palm thrives especially well. No specimens were found near the shore.



Sexual zone.



Spermatheca.

DETAILED DESCRIPTION.

Characteristics.—The principal differences between the species and the variety are found in the sexual zone, the form of the spermathecæ, the faint ornamentation of the setæ, and the relative size of the muscular and glandular parts of the prostates.

The septal formula is as follows:

IV/V, V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Intestine.—The tubular part is narrow and even and joins a vascular crop in XIV. This crop is more vascular than that of the species and is shorter and narrower. It is also strongly contracted at the septa, which is not the case in the species.

Sperm-duct.—In a recent paper Michaelsen (30) has given great importance to the assertion of A. Iizuka, that the sperm-duct in *Pontodrilus matsushimensis* Iizuka traverses the wall of the whole glandular prostate in order to enter it at its distal free end. Iizuka assumes that this peculiarity is a common characteristic of all species of the genus. A re-examination of the type specimens of *P. Michaelseni*, as well as a careful study of two sets of serial sections of the variety in question, shows conclusively that the sperm-duct enters at once and directly into the glandular prostate at a little distance above its junction with the muscular part. There is, however, a long and thick blood-vessel which takes the same course as the sperm-duct figured by Iizuka. Michaelsen (30, p. 221, line 10), who has described a variety of the Japanese species (*P. masushimensis* var. *chatamianus*), appears to be somewhat uncertain about the exact point of entrance of the sperm-duct. Under these circumstances it seems to be premature to place any great importance on the possibly aberrant structure of the sexual apparatus of the Japanese species.

Spermathecæ.—The spermathecæ are much larger than in the species. They occupy the largest part of their respective somites. The form of the main sac is also different from that of the species.

Nephridia.—As in the species these organs begin in somite XIII. The nephridia anterior to the clitellum are furnished with only a few accessory cells, while those

posterior to the clitellum are covered with a thick cœlomic mantle, which seems more uneven and more rugose than that of the species.

Setæ.—The ornamentation of the setæ is exceedingly faint. The tip of the setæ at first glance appears to be perfectly smooth, and it is only with a good homogeneous immersion lens that the faintest of marginal impressions—too faint to be illustrated in a drawing without being exaggerated—can be perceived.

The various species of *Pontodrilus* are closely related and a careful reconsideration of all the forms would prove of great interest.

LIMNODRILIDÆ.

Telmatodrilus *Eisen.*

A second species of this genus is not uncommon in California, and it is not improbable that the two species were at first confounded. The following definition will distinguish the two species thus far known:

Telmatodrilus Vejdovskyi *Eisen.*

Definition.—Body stiff, sluggish, slightly tapering. Spermathecæ opening in front of and between the ventral fascicles of setæ in X. The setæ are indistinctly uncinate.

Habitat.—Sierra Nevada Mountains, in the medium dry soil of marshes and meadows, or in rotten logs in wet places.

This definition is drawn from my first description, the type-specimens not being accessible. Beddard, in his Monograph of Oligochæta, page 263, gives a definition of *T. Vejdovskyi*, differing in some respects from that originally given by the author. His description is probably partly based on specimens which I sent him in 1892. Beddard states that the spermathecal pores open between the dorsal and ventral bundles of setæ, making it evident that he had

before him not *T. Vejdovskyi*, but *T. McGregori*. The specimens sent to Professor Beddard at his request were not closely examined, hence the error.

Telmatodrilus McGregori, sp. nov.

Definition.—Body not stiff, less sluggish, and more tapering towards the tail than in the former species. Spermathecæ opening in front of and between the ventral and lateral fascicles of setæ in X. Setæ distinctly uncinate, especially those of the ventral fascicles.

Habitat.—California, in the Sierra Nevada Mountains, generally at high altitudes, lower in the northern part of the State than in the southern. Specimens are in the collection from the following localities: Castle Crag, Shasta County, in an irrigation ditch close to the hotel; Phil Hope Spring, about six miles east of the town of Coulterville, Mariposa County, and a few miles north of Dog Town, at the top of the gulch: 3—Spring Meadow, on the east side of the North Fork of King's River, Fresno County, at an altitude of about 8,000 feet; in springs on the east side of Dinkey Creek, Fresno County, a mile or so from Frank Dusey Camp, near the head-waters of the creek, at an altitude of 6,000 feet.

The species is named for Richard C. McGregor, to whom the author is indebted for many new species of Oligochæta.

DETAILED DESCRIPTION.

As will be seen, the principal character concerns the spermathecal pores, which in *T. McGregori* are situated in front of the lateral intervals, while in *T. Vejdovskyi* they are found in front of the ventral interval.

Body.—Length in fully extended specimens 40 to 60 mm., width about 1 mm. Body strongly tapering towards the tail. More slender and more active than *T. Vejdovskyi*.

Setæ.—Beginning with somite II, there are four fascicles in every somite, each containing from 6 to 14 setæ. The setæ of the lateral fascicles are indistinctly uncinate, while those of the ventral fascicles are distinctly so. The anterior setæ, or those in somites II to IX inclusive, are larger than

those following. The anterior fascicles have more setæ than the posterior ones, somite II having about 14 setæ in the lateral fascicles and from 10 to 12 in the ventral ones. This number gradually diminishes posteriorly, until in somite IX there are about eight setæ in the lateral fascicles and six in the ventral. In somite XI and following the setæ are considerably smaller. The setæ are more sigmoid and more thickened in the middle than those in the former species.

Pores.—The male pores are situated in somite XI, immediately lateral and dorsal to the ventral fascicles of setæ, and in such close proximity that the setæ just clear the male pore, the pores and the fascicles thus being in the equatorial of the somite. The spermathecal pores are situated half-way between the anterior margin of the somite and the equatorial line between the ventral and lateral fascicles of setæ. The pores of the nephridia are in line with the ventral fascicles of setæ and near to the anterior margin of the somite.

Intestine.—There is a strong muscular pharynx but it does not carry any suprapharyngeal gland. There is, however, a row of septal-pharyngeal glands opening into the pharynx. These glands extend posteriorly to and include somite VII. The most anterior gland is in IV, attached to the anterior face of the septum III/IV. These glands are principally developed ventrally and laterally, that in VII ventrally only. The individual cells in these glands are much separated, similar to those in *Enchytræidæ*. The tubular intestine is narrow, nipped by the septa, and extends to somite XI. In XII it enlarges into a sacculated intestine, which is generally very large in XII, XIII and XIV, gradually narrowing down. The tubular intestine and the sacculated intestine from somite XIV, posteriorly, are covered with small chloragogen cells which are lacking in XII and XIII.

Blood-vessels.—The perivisceral vessels in the anterior somites gradually increase in size posteriorly, but the pairs in X and XI are considerably larger, serving as heart-

There is no heart-body. The dorsal vessel is generally, but not always, situated on one side of the body. It is much larger in XII and XIII.

Testes.—There is one pair of testes in somite X, occupying the usual position. They extend backwards and connect with a median, dorsal sperm-sac, which extends to the middle of somite XII.

Ovaries.—There is one pair of ovaries in somite XI, extending from the anterior septum backwards, and filling a large part of the somite. The oviducts are very small; the ovipores are in front of and in line with the ventral fascicles of setæ in XII.

Spermathecæ.—The spermathecæ are simple sacs, one-half shorter than those figured for *T. Vejdovskyi*. They are strongly muscular from the apex to the pore. There are no spermatophores.

Sperm-ducts and Penis.—These organs, which open on XI, resemble those figured for *T. Vejdovskyi*. There is no chitinous sheath in the penis, and I have reason to think that there is none in the other species of this genus. The atrium, into which open the many prostates, is always strongly bent, either sideways, forwards or backwards. It is strongly muscular, the muscular layer being circular. The sperm-duct joins the atrium abruptly, and is about one-third narrower. It descends downwards at once, with a few slight folds, and then widens out to a flaring funnel which is invested in the septum X/XI. The penis itself projects alongside of a rather strong copulatory cushion situated immediately dorsal to the male pore. Between it and the ventral fascicle of setæ there is a deep pit, through which the penis is protruded. There are ten to fifteen prostate glands of about the same diameter as the atrium.

Nephridia.—There are no nephridia in the genital somites. Posterior to the clitellum the nephridia commence in somite XVI. Only the posterior nephridia are covered with large bladder-like peritoneal cells.

APPENDIX.

METHODS OF COLLECTING.

It is often inconvenient to dig for worms, the holes and casts of which can be seen in abundance over the top of the ground. In such instances the author has had recourse to one of two methods, either of which will cause the worms to rapidly seek the surface of the soil. The first of these methods was used by the Indians of California years ago, when *Argilophilus* species were used for food. A long crowbar is driven vertically into the soil and worked sideways for a few minutes, when the worms will leave their holes and come to the surface, where they may easily be gathered up. They may also be forced to come out of the ground by wetting the soil with a weak solution of sulphate of iron in water. A teaspoonful of the sulphate dissolved in a bucket of water and poured over the ground will soon cause the worms to make their appearance. As the epidermis is irritated by this means, the specimens should be preserved as soon as possible.

CARE OF THE WORMS.

Oligochæta may be safely transported alive for thousands of miles even in tropical climates, providing sufficient care be taken. They can best be sent in a closed box which is entirely filled with soil, thus preventing movement from side to side. The soil must be moist, but never wet. The box with soil should always be enclosed in a larger box, and the space between filled in with wood shavings or "excelsior."

A better way is to use moss, especially sphagnum moss, instead of soil. The moss should be soaked in water, then squeezed by hand until no more water can be gotten from it. The box in which the worms are to be placed should be packed full of the moss and placed in a larger box with damp moss around it. Any water in the box will cause the worms to die. No broken or injured worms must ever be placed among the lot. Upon being received the worms should be washed in clean water; they are then ready to be cleaned from sand.

The author finds the quickest and most satisfactory way of freeing specimens from sand is to place them in a wet handkerchief or other cloth of cotton or linen. The cloth should be slightly wet and the worms wrapped up in it and placed in a glass jar closely covered. If the jar be now placed in a perfectly dark place the worms will crawl about and free themselves from sand. This method was found to be more satisfactory than the use of blotting paper.

NARCOTIZING.

A good way of narcotizing the worms previous to killing them is to use chloroform as recommended by Perrier. A few precautions are nesessary. Only a couple of drops should be used, and must not be mixed with the water. A disregard of these precautions will cause the worms to become distorted and to burst open in places. The direct influence of the chloroform vapors also has the same effect. It is best to place the specimens in a flat dish and cover

them well with water. In the center of the dish is placed a heavy but short vial containing only a few drops of chloroform. The whole is covered with a bell-jar. The chloroform may also be dropped on a piece of cotton or blotting paper and placed on a large piece of cork floating on the surface of the water, or simply left on the table. It must, however, never come in direct contact with the water. In from fifteen minutes to two hours, or when the worms are fully stretched out, they are ready to be killed with the fixative.

A method to be recommended in handling delicate and thin-skinned worms is to place them in water to which from time to time are added a few drops of a saturated solution of bichloride of mercury in water. In half an hour the worms should be fully stretched out and ready to be fixed.

FIXATIVES AND IMBEDDING.

The best and most practical fixative for Oligochæta the author finds to be a solution of bichromate of potassium with acetic acid, according to the following formula:—

Bichromate of potassium 3 parts.
Glacial acetic acid 6 parts.
Water 100 parts.

The worms are fixed in this solution for about twenty-four hours and afterwards washed in running water for several hours until no trace is left of the yellow color.

This fixative is cheap and easily carried on collecting trips; it has an advantage over sublimate in being non-poisonous and requiring no iodification; it allows of excellent staining and fixes better than sublimate-acetic.

A cheap fixative and preservative for the use of traveling collectors consists of two per cent. of formaldehyde in 33 per cent. of alcohol. This preservative allows of good staining and does not make the specimens brittle. It is, however, inferior to the sublimate-acetic and the bichromate-acetic fixatives. The worms are dropped into the solution, which should be replaced by fresh after twenty-four hours.

Worms which are to be sectioned lengthwise should not be as straight as those which are to be sectioned transversely. If they are slightly curved it is much easier to orientate their ventral and dorsal sides when placing them in the paraffin imbedding. The worms curve either ventrally or dorsally, and even the slightest curve will enable one to place them so that the sections will pass directly through the dorsal and ventral line. Sections destined for transvere sectioning should be perfectly straight. This is best accomplished by placing them between thin glass rods.

As soon as the worms are dead and before they become stiffened place them in a dry, shallow dish with a flat bottom. After straightening each worm out place along side of it a round glass rod, as thick or slightly thicker than the worm. By alternating worms and glass rods, the whole bottom of the dish may be covered and the worms kept perfectly straight.

The fixative is at first applied slowly, drop by drop, so as not to disturb the specimens; but as soon as they are sufficiently hardened they should be entirely covered with the fixative. If the worms are large it may be necessary to replace the liquid by fresh. More than four hours immersion is not advisable.

The after treatment offers no peculiarities and is understood by every biologist accustomed to laboratory work. The worms are preserved in alcohol which should be changed as soon as it becomes yellow, or in a solution of formaldehyde in water, or in a one per cent. solution of formaldehyde in thirty per cent. of alcohol. Specimens should on no account be kept any length of time in strong formaldehyde, as it greatly injures them.

Some worms contain sand or other hard substances, which must be gotten rid of before sectioning. An easy method is to cut the specimen lengthwise with a pair of fine scissors, and then to wash the sand from the intestine. In this way one-half of the body may be sectioned lengthwise and the other half transversely.

The sections are best mounted on slides by the alcoholic method (Eisen 23).

When the worms are removed to vials, they should be placed head downwards, in order to prevent this part from becoming accidentally dried. Do not place too many specimens in one vial, as they will macerate and become useless. If, however, space is limited and it is desirable to crowd the specimens, the formalin solution may be changed several times until it remains perfectly clear after standing for several days. The worms must be hard and solid when stored away. It is very important that the vials should be full of the solution, so that when turned about the worms will not move. A piece of paper placed in the top of the vial will also prevent any shaking up. Fill the vial full of liquid, drop a string down into the neck of the vial and then insert a cork. Press down the cork and at the same time pull out the string. The air in the bottle will escape and the cork can be pushed down to the very liquid, thus leaving no room for air. Even comparatively small air bubbles will allow the contents of the bottle to shake about, causing the ruin of the specimens. The best paper to place in the bottles is soft white tissue paper. Toilet paper will not do as it dissolves.

When glass vials are to be sent away they should always be packed in a box which is enclosed in another box, with soft packing between the two. A label of stiff paper on which is written in lead pencil the date and locality, and whether collected in soil, in the mud of rivers, in moss, etc., should always be placed inside the vial.

DISAPPEARANCE OF NATIVE SPECIES.

It is not my intention to enumerate here all the localities in which native worms abide; indeed, they are to be found almost everywhere in the soil, and in the banks and bottoms of rivers and streams. In collections received from generous friends and donors it has often been a great disappointment to find the large majority of the specimens to be worms imported from Europe, instead of native species, which are the only ones of real interest to us.

Collectors generally hunt for earthworms in manure piles or in gardens, and it is in just such places that the accidentally imported European worms flourish to the exclusion of the native species. In California and in the southern States generally, it is now almost impossible to find in rich garden soil and in manure piles any other than common, European varieties.

Native Oligochæta are to be found in the virgin soil of the country, far from gardens and manure heaps; in the moist soil of gulches and mountain meadows;

under native trees and shrubbery; in the mud of streams; under rotten and decaying stumps and leaves in the forest; under moss and the rotting seaweeds on the coast. It is in such localities that we must search for our native Oligochæta.

The large worms are generally the best known; the smallest have been neglected, and it is principally among these latter that we may hope to find new and interesting species. The small white worms so common in the north are but little known; so also are the forms found in the mud of rivers and springs. On the Pacific Coast the native worms are generally of a pale gray or flesh color. The European species are as a rule darker, the reddish or brownish color being due to heavy pigments.

The reason for the European species supplanting the native forms is probably due to several causes. The former are much hardier and may be easily transported from one locality to another without injury. They are less sensitive to heat and light, which is probably due to their pigmentation. As a rule they are adult all the year round, while the native species are adult only in the first half of the rainy season; therefore the European species have a longer breeding season and can better adapt themselves to climatic conditions. The European worms seem to have grown up in the vicinity of man and have accommodated themselves to his cultivation of the soil, which cultivation drives the native worms away. While this refers especially to the worms in our temperate regions, it is also the case in the highlands of Mexico and to some extent in the tropics. The encroachment of the European Terricolæ is such that in time there will be few if any native species left. Of the smaller foreign *Limicolide* worms, but few seem as yet to have spread in this country.

It is of the greatest importance when collecting to remember the fact that nearly all earthworms when adult possess a different colored band—the clitellum—on the anterior part of the body. If this band is not present the species cannot be identified.

METHODS OF INDICATING THE THICKENED SEPTA.

Many investigators satisfy themselves with simply describing some septa as thickened. This, of course, does not indicate the relative thickness, and if it be given in the text much time is consumed in committing it to memory. The following method of indicating the relative thickness of the septa is suggested by the author. Septa are to be indicated by Roman numerals, a bar on top indicates that the whole septum is thickened, a bar below indicates that it is thickened only below. One bar indicates twice the thickness of the ordinary septum, and two or more bars indicate increased thickness. "O" in place of the Roman numeral indicates that the septum is wanting. A fraction in front of a numeral indicates that the septum is attached to the center of the somite and does not correspond to the intersegmental groove. For examples of this method the reader is referred to the descriptions under species. A single bar may indicate that the septum is as thick as two ordinary septa, a bar and a half (——═══) may indicate that the septum in question is one and one-half times thicker than an ordinary septum. If the septum is thickest in the center, this may be indicated by diminishing the bars toward both ends.

BIBLIOGRAPHY.

BEDDARD, FRANK E.

(20). On the Anatomy of Ocnerodrilus (Eisen). *Trans. Roy. Soc. Edinburgh*, Vol. XXXVI, 1892, Part 2, p. 563.

(23). Some New or Little Known Oligochæta. *Proc. Roy. Phys. Soc. Edinburgh*, Vol. XII, 1892, p. 33.

(37). On the Oligochætous Fauna of New Zealand, with Preliminary Descriptions of New Species. *P. Z. S.* London, 1889, p. 381.

(38). On the Earthworms collected in Algeria and Tunisia by Dr. Anderson. *P. Z. S.* London, 1892, p. 32.

(41). Descriptions of Some New or Little Known Earthworms, together with an Account of the Variations in Structure exhibited by Perionyx excavatus, E. P. *P. Z. S.* London, 1886, p. 298.

(45). On Certain Points in the Structure of Urochæta, E. P., and Dichogaster, nov. gen., with further Remarks on the Nephridia of Earthworms. *Q. J. M. S.*, Vol. XXIX, 1889, p. 235.

(54). On the Structure of Two New Genera of Earthworms belonging to the Eudrilidæ and some Remarks on Nemertodrilus. *Q. J. M. S.*, Vol. XXXII, 1891, p. 235.

(57). On Some New Species of Earthworms from various parts of the World. *P. Z. S.* London, 1892, p. 666.

(61). Observations on the Structural Characters of certain new or little-known Earthworms. *Proc. Roy. Soc. Edinburgh*, Vol. XIV, 1887, p. 156.

(63). Contributions to the Anatomy of Earthworms, No. IV. *P. Z. S.* London, 1887, p. 544.

(85). On Two New Genera, comprising Three New Species, of Earthworms from Western Tropical Africa. *P. Z. S.* London, 1894, p. 379.

(86). A Monograph on the Order of Oligochæta. London, 1895.

(87). Preliminary Account of New Species of Earthworms belonging to the Hamburg Museum. *P. Z. S.* London, 1895, p. 210.

(88). Naiden, Tubificiden und Terricolen bearbeited von F. E. Beddard. *Hamburger Magalhaensische Sammelreise.* Hamburg, 1896.

BENHAM, W. B.

(3). Studies on Earthworms. No. II. *Q. J. M. S.*, Vol. XXVII, 1886, p. 77.

(8). Descriptions of Three new Species of Earthworms. *P. Z. S.* London, 1892, p. 136.

(13). The Genera Trigaster and Benhamia. *Ann. & Mag. Nat. Hist.*, 6th Ser., Vol. VI, 1890, pp. 414-417.

EISEN, GUSTAV.

(1). Anatomical Studies on New Species of Ocnerodrilus. *Proc. Cal. Acad. Sci.*, 2d Ser., Vol. III, 1893, p. 228.

(9). On the Anatomy of Ocnerodrilus. *Nov. Act. Soc. Upsal.*, 3d Ser., Vol. X, 1879, p. 1.

(16). On California Eudrilidæ. *Mem. Cal. Acad. Sci.*, Vol. II, No. 3, 1894.

(17). Pacific Coast Oligochæta, —I. *Mem. Cal. Acad. Sci.*, Vol. II, No. 4, 1895.

(18). Pacific Coast Oligochæta, —II. *Mem. Cal. Acad. Sci.*, Vol. II, No. 5, 1896.

(19). Pontoscolex Lilljeborgi, with Notes on Auditory Sense Cells of Pontoscolex corethrurus. *Zool. Stud. Festschrift Wilhelm Lilljeborg zum achtzigsten Geburtstag gewidmet von Schwedischen Zoologen.* Upsala, 1896, p. 1.

(20). Plasmocytes: The Survival of the Centrosome and Archoplasm of the Erythrocytes in the Blood of Batrachoseps attenuatus Esch. *Proc. Cal. Acad. Sci.*, 3d Ser., Zool., Vol. I., No. 1, 1897.

(21). Explorations in the Cape Region of Baja California in 1894. *Proc. Cal. Acad. Sci.*, 2d Ser. Vol. V, 1895, p. 733.

(22). Notes on North American Earthworms of the Genus Diplocardia. *Zool. Bull.*, Vol. II, No. 4, 1899, p. 161. Boston.

(23). Notes on Fixation, Stains, the Alcohol Method, etc. *Zeitsch. wiss. Mik.*, Bd. XIV, 1897, p. 195.

FLETCHER, J. H.

(3). Notes on Australian Earthworms. Part. III. *Proc. Linn. Soc. N. S. W.*, 2d Ser., Vol. II, 1887, p. 378.

GARMAN, H.

(1). On the Anatomy and Histology of a New Earthworm (Diplocardia communis, gen. et sp. nov.) *Bull. Illinois Lab. Nat. Hist.*, Vol. III, 1888, p. 47.

GOODRICH, E. S.

(1). Notes on Oligochætes, with the Description of a New Species. *Q. J. M. S.*, Vol. XXXIX, 1897, p. 51.

HESSE, R.

(2). Untersuchungen über die Organe der Lichtempfindung bei Niederen Thieren. *Tübinger Zoologische Arbeiten*, Bd. II, No. 2, 1896.

HORST, R.

(7). Vermes, Natuurlijke Historie Sumatra. Twaalfde Afd.

(17). Earthworms from the Malay Archipelago. *Zool. Ergebnisse einer Reise in Niederlandisch Ost-Indien.*, Bd. II, 1892, p. 28.

IIZUKA, A.

(1). On a New Species of Littoral Oligochæta (Pontodrilus matsushimensis). *Annot. Zool. Japon.*, Vol. II, 1898, p. 21. Tokyo.

MICHAELSEN, W.

(6). Beschreibungen der von Herrn Dr. Fr. Stuhlmann auf Sansibar und dem Gegenüber-Liegenden Festlande gesammelten Terricolen. *Jahrb. der Hamburg. wiss. Anstalten*, Bd. IX, 1891, p. 66.

(10). Terricolen der Berliner Zoologischen Sammlung, I. Africa. *Arch. f. Naturgesch.*, Bd. LVII, 1891, p. 8.

(13). Oligochæten des Naturhist. Museum in Hamburg. II. *Jahrb. d. Hamburgischen wiss. Anstalten*, Bd. VI, 1889, p. 10.

(16). Regenwürmer. Die Thierwelt Ost-Africas. *Deutsch-Ost-Afrika*, Bd. IV, 1895.

(17). Zur Systematik der Regenwürmer, *Verh. d. Nat. Vereins zu Hamburg*, Dritte Folge II, 1894, p. 18.

(18). Zur Kenntnis der Oligochæten. *Abhandl. aus dem Gebiete der Naturwiss.* Hamburg., Bd. XIII, 1895, p. 1.

(19). Die Regenwürm-Fauna von Florida und Georgia. *Zool. Jahrb. Abth. f. Syst.*, Bd. VIII, 1894, p. 177.

(21). Weiterer Beitrag zur Systematik der Regenwürmer. *Verh. d. Naturwiss. Ver. zu Hamburg*, 1896, Dritte Folge, Bd. IV, p. 1.

(28). Die Oligochæten der Sammlung Plate. *Fauna Chilensis*, Heft II, 1898, p. 477. Jena.

(29). Ueber eine neue Gattung und vier neue Arten der Unterfamilie Benhamini. *Jahrb. d. Hamburg. wiss. Anstalt.*, Bd. XV, Beiheft 2, 1898. Hamburg.

(30). Oligochäten von den Inseln des Pacific, nebst Erörterungen zur Systematik der Megascoleciden. *Zool. Jahrb. Abth. f. Syst.*, Bd. XII, 1899, p. 211.

PERRIER, ED.

(5). Études sur L'Organisation des Lombriciens Terrestres. *Arch. Zool. exp. et gen.*, Tom. III, 1874, pp. 331–350.

(8). Étude sur un Genre nouveau de Lombriciens (Genre Plutellus, E. P.) *Arch. Zool. exp. et gen.*, Tom. II, 1873, pp. 245–268.

ROSA, DANIELE.

(42). I Limfociti degli Oligochæti. *Accad. R. d. Sci. d. Torino*, 2d Ser., Tom. XLVI, 1895–96.

(1). I Lombrichi raccolti nell'isola Nias dal Signor E. Modigliani e descritti dal. *Ann. d. Museo Civico d. Storia Nat.* Genova. Ser. 2a, Vol. VII, 1889, p. 125.

(17). Microscolex modestus (n. gen., n. sp.) *Boll. Musei Zool. Anat. Univ. Torino*, No. 19, Vol. II, 1887.

(40). Contributo Allo Studio dei Terricoli Neotropicoli. *Mem. Accad. R. d. Sci. d. Torino*, 1894–1895.

SMITH, FRANK.

(1). A Preliminary Account of Two New Oligochæta from Illinois. *Bull. Illinois Lab. Nat. Hist.*, Article V, Vol. IV, 1895, p. 138.

(2). Notes on Species of North American Oligochæta. *Bull. Illinois Lab. Nat. Hist.*, Article VIII, Vol. IV, 1895, p. 285.

(3). Notes on Species of North American Oligochæta, —II. *Bull. Illinois Lab. Nat. Hist.*, Vol. IV, 1892–97, p. 407.

(4). Upon an Undescribed Species of Megascolides from the United States. *American Naturalist*, Vol. XXXI, March, 1897, p. 202.

UDE, H.

(4). Beiträge z. Kenntnis ausländischer Regenwürmer. *Zeit. f. wiss. Zool.*, Bd. LVII, 1894, p. 57.

(5). Beiträge z. Kenntnis der Enchytraeiden und Lumbriciden. *Zeit. f. wiss. Zool.*, Bd. LXI, 1896, p. 129.

(6). Über zwei neue Lumbriciden-Arten aus Nordamerika. *Zool. Anz.*, Jahrg. XVIII, 1895, No. 483, p. 339.

INDEX TO AMERICAN OLIGOCHÆTA.

New genera and species in full face, synonyms in *italics*.

SIGNIFICANCE OF REFERENCE LETTERS.

a. ep. — epithelium in the anterior part of the somite.
a. f. — anterior fold of nephridia.
am. cy. — amœbocytic chloragogen cells.
arch. s. — archosomal structures
bd. — body-wall.
bd. w. — body-wall.
bl. — blood-sinus.
bl. cap. — capillaries.
bl. m. — membrane of blood-sinus.
bl. s. — blood-sinus.
bl. v. — blood-vessel.
br. — brain.
bu. c. — copulatory bursa.
cal. — calcic concretions.
cal. div. — calciferous diverticle.
cal. gl. — calciferous glands.
cap. — capillaries.
caud. reg. — caudal region.
caud. z. — caudal zone.
c. b. c. — cushion copulatory bursa.
c. c. — copulatory cushion.
cen. c. — central cell.
c. ep. — ciliated epithelial cells.
cham.sex.gl. — discharge chamber of sexual glands.
chlo. — chloragogen cells.
cl. c. — clitellar cells.
cl. gl. — clitellar glands.
clit. — clitellum.
clit. c. — clitellar cells.
c. m. — circular muscles.
co. bu. — copulatory bursa.
cœ. — cœcum.
cœc. — cœcal pouch of nephridium.
cœl. ep. — cœlomic epithelium.
con. t. c. — connective tissue cells
co. p. — copulatory papilla.
cp. — capillaries.
c. p. — copulatory cushion.
c. p. — copulatory papilla.
cr. — circular muscles.
cr. — sperm-funnels.
cr. m. — circular muscles.
cu. — cuticle.
c. va. — vacuole in cytoplasm.
cy. di. — cytoplasmic diaphragm.
d. — diverticles of intestine
d. c. d. — duct of calcic diverticle.
div. pr. — diverticle of prostate.
d. pr. — duct of prostate.
ducts.sex.gl. — ducts sexual glands.
d. v. — dorsal vessel.
d. y. gl. — duct of y-gland.
eg. c. — egg-cell.
ep. — epithelium.
epd. — epidermis.
e. sp. d. — entrance of sperm-ducts.
f. — duct of funnel.
f. — folds.
gl. — ganglion.
gl. c. — glandular cells.
gl. d. — ducts of glands.
gl. p. — discharge pockets of glands.
gr. — groove.
h. — heart.
h. b. — horseshoe-like bend.
i. li. — interior lips.
int. — intestine.
int. cr. m. — intestinal circular muscles.
int. ep. — interior epithelium.
int. seg. — intersegmental groove
int. ty. ca. — intra-typhlosolar canals.
lam. cy. — cytoplasmic lamella.
l. c. — lymphocytes.
l. div. pr. — lumen of diverticle of prostate.
l. gro. — longitudinal groove.
l. m. — longitudinal muscles.
l. n. — nuclei of lymphatics.
l. p. — lumen of penis.
l. pr. — lumen of prostate.
ly. — lymphatic tissue.
lyc. — lymphocytes.

ly. t. — lymphatic tissue, or lymphatic glands.
m. — muscles.
m. c. — cell-cap.
m. c. — muscular cushion.
mes. — mesenteries.
m. l. — muscular layers.
ms. — muscular layer.
m. ty. ca. — intra-typhlosolar canals.
n. d. — nephridial duct.
neph. — nephridium, or part of nephridium.
neph. p. — nephropore.
nephr. st. — nephrostome.
n. gl. — nerve ganglion.
n. st. — nephrostome.
o. bu. c. — orifice copulatory bursa.
oe. — œsophagus.
oes. — œsophagus.
or. — orifice of diverticle.
or. cal. div. — orifice calcic diverticle
or. sex. gl. & setæ. — orifice of sexual glands, etc.
or. y. gl. — orifice of y-gland.
otos. — otosome.
o. ov. — orifice of ovary.
ov. — ovary.
ov. 1. — anterior ovary.
ov. 2. & ovs. — posterior ovary with ovicells.
ovd. — oviduct.
ovd. gl. — oviducal gland.
ovd. ov. 1. — oviduct of anterior ovary.
ovd. ov. 2. — oviduct of posterior ovary.
ov. f. — oviducal funnel.
p. — penis.
pa. — papilla.
pa. y. gl. — papilla of y-gland.
pc. — penis.
p. ep. — epithelium in the posterior part of the somite.
per. — peritoneum.
peri. — peritoneum.
p. f. — posterior fold of nephridium.
p. f. — posterior fold.
phx. — pharynx.
phx. gl. — pharyngeal glands.
po. b. c. — pore copulatory bursa.
p. p. — papillæ.
pr. — prostate and diverticle.
pr. — prostomium.
pr. b. c. — pore of copulatory bursa.
pr. d. — duct of prostate.
pr. pr. — prostate pore.
pr. st. d. — dorsal part of prostomium.
pr. st. v. — ventral part of prostomium.
pr. y. gl. — pore of y-gland.
p. s. — penial setæ.
s. — septum.
sa. b. — setæ *ab.*
sac. int. — sacculated intestine.
s. c. — sense-cells.
s. c. tub. pub. — supporting cells of t. p.
sept. — septum.
sex. gl. — sexual glands.
sex. set. — sexual setæ.
s. gl. — septal glands.
s. h. — sense-hairs.
s. int. — sacculated intestine.
s. int. v. — supraintestinal vessel.
sp. d. — sperm-duct.
s. pha. gl. — suprapharyngeal glands.
spr. — spur.
sp. s. — sperm-sacs.
spth. — spermatheca.
spth. d. — spermathecal duct.
spth. p. — spermathecal pore.
spz. — spermatozoa.
sub. in. v. — subintestinal vessel.
su. c. — supporting cells.
sup. c. — supporting cells.
su. ph. gl. — suprapharyngeal glands.
t. — testes.
t. c. — taste cells.
t. gr. — t-shaped groove.
t. int. — tubular intestine.
t. m. — transverse muscular layer.
tr. m. — transverse muscles.
tub. — tubular intestine.
tub. in. — tubular intestine.
tub. p. — tubercula pubertatis.
tub. p. c. — tubercula pubertatis cells.
typh. — typhlosole.
v. gl. — ventral ganglion.
w. — windings of nephridia ducts.
w. bl. v. — wall of blood-vessel.
y. gl. — y-gland.

EXPLANATION OF PLATE V.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 1. Specimen natural size.
Fig. 2. Anterior somites, ventral view.
Fig. 3. Anterior somites, side view. The nephropores are seen to be in front of the setæ *cd*. Setæ *cd* in II are further apart, larger and also more dorsal than the corresponding setæ in other somites.
Fig. 4. Anterior somites, side view. Prostomium retracted. More magnified than figs. 2 and 3.
Fig. 5. Clitellar somites, side view, showing the tubercula pubertatis and the enlarged glandular area around the setæ.
Fig. 6. Part of the body-wall of the anterior somites spread out, showing the location of anterior setæ. There is no nephridium in III. Setæ *cd* in II are further apart, larger and more dorsal than those in III, IV, etc.
Fig. 7. A penial seta from clitellum.
Fig. 8. One of the spermathecæ.
Fig. 9. Longitudinal section of the anterior somites. Zeiss *a* 2, Oc. 12. (*s*) Much enlarged septum III/IV; (*m*) muscles to which are attached the suprapharyngeal glands and muscles connecting this septum with the body-wall. The former are fastened to the very large septum separating III/IV.
Fig. 10. Part of the pharynx, showing the discharge-pockets of the unicellular glands.
Fig. 11. Longitudinal section of the body-wall of somites VII and VIII, passing through the spermathecal and nephridial pores, showing the opening of the former in the posterior part of the somite, in front of the septum separating VII/VIII. Zeiss D., Oc. 2.
Fig. 12. A nephridium dissected out, from a somite next posterior to clitellum; *gl. p.*, glandular pouch; *br.*, bridge of nephridium.
Fig. 13. The part surrounding the glandular pouch of another nephridium; *gl. p.*, glandular pouch; *f.*, duct to the folds; *n. d.*, narrow duct connecting with the nephrostome.
Fig. 14. Section of the nephridial sphinxter at its interior end.
Fig. 15. Section of the nephridial sphinxter at its outer end, showing a ciliated inner epithelial lining.
Fig. 16. A part of the former figure more highly magnified.

EXPLANATION OF PLATE VI.

Pontoscolex corethrurus (FR. MÜLLER), *mexicanus*, subsp. nov.

Fig. 17. Longitudinal section of the body-wall in somite IV, showing the arrangement of the muscular layers.

Fig. 18. Cross-section of part of the body-wall in somite IV. Zeiss D., Oc. 4. The letters indicate the same as in fig. 17.

Fig. 19. Cross-section of the body-wall in one of the clitellar somites, showing tubercula pubertatis.

Fig. 20. A highly magnified part of the tubercula pubertatis, Zeiss $\frac{1}{12}$, Oc. 2.

Fig. 21. Part of the body-wall from the caudal zone, showing the various epidermal cells.

Fig. 22. An isolated vibratory sense-cell.

Fig. 23. Cross-section of the worm, one of the somites containing calciferous diverticles.

EXPLANATION OF PLATE VII.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 24. Cross-section of a calciferous diverticle. Zeiss Apo. 2 mm., 1.40, Oc. 4.

Fig. 25. Cross-section of a calciferous diverticle at its connection with the intestine.

Fig. 26. Longitudinal section of the tubular intestine, where it opens into the sacculated intestine, showing the thickened transverse muscular layer in somites XVI and XVII; *ep.*, epithelial cells; those in XVII ciliated.

Eudrilus Eugeniæ (KINBERG).

Fig. 27. Specimen natural size.

Fig. 28. Anterior somites, dorsal view.

Fig. 29. Clitellar somites, ventral view.

Fig. 30. Exterior male apparatus, the copulatory bursa everted (side view). The narrow crescent-shaped penis is seen to encircle the large papilla on which opens the Y-gland. This papilla is contracted at the middle and pointed at each end.

Fig. 31. Male copulatory apparatus with the bursa everted (front view). Letters same as in fig. 30.

Fig. 32. A male copulatory apparatus with only partly everted bursa (front view).

Fig. 33. The same as above, side view, showing the groove, beginning about half-way between apex and base. The pore of the prostate is near the apex.

Fig. 34. Apex of penis showing groove and pore of prostate.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 35. Lacking.

Fig. 36*a*. Section of intestine showing typhlosole.

Fig. 36*b*. Detail of the typhlosole.

Fig. 37. Transverse section of the upper part of the typhlosolar region, including dorsal vessel, the chloragogen cells and intra-typhlosolar canals; Zeiss Apo. 2 mm., Oc. 4; (*a*), the whole upper region with a single central intra-typhlosolar canal; (*b*), a section of the same region, but with two canals of unequal size; (*c*), a section where an intra-typhlosolar canal opens into the upper part of the intestine. Only part of the details are carried out, the indicated parts being similar to those of fig. 37*a; in. ty. ca.*, intra-typhlosolar canals; *inv. cr. m.*, invagination of circular muscular layer around the typhlosole.

Fig. 38. Lacking.

Eudrilus Eugeniæ (KINBERG).

Fig. 39. The two median diverticles of the intestine in somites X, XI, showing the very narrow connection with the intestine as well as their relative size (longitudinal section); *sub. in. v.* subintestinal vessel, not divided in any part of the somite.

EXPLANATION OF PLATE VIII.

Eudrilus Eugeniæ (KINBERG).

Fig. 40. Transverse section of a median calciferous diverticle of the intestine. The section passes through the junction with the intestine.

Fig. 41. Transverse section of the median diverticle of the intestine. Only a few of the numerous calcic crystals figured.

Fig. 42. Subintestinal vessel surrounded by lymphatic tissue. The dark dots represent nuclei. Zeiss *AA*., Comp. Oc. 6.

Fig. 43. A highly magnified detail of the former. The solid black represents blood. Zeiss, Apo. 2 mm. Comp. Oc. 4.

Fig. 44. Male apparatus, in longitudinal section. The figure is constructed from a number of sections and is to some degree diagrammatic. The section does not show the free, external parts of the organ; *div. pr.*, diverticle of the prostate joining the main prostate at the point ×; *e. sp. d.*, entrance of sperm-ducts into the main prostate; *m. s.*, muscular layers of prostate enclosing both the main prostate and its diverticle; *p.*, section of penis. The large central lumen is the duct from the prostate. Below this is seen a T-shaped groove. The Y-gland opens out just opposite this groove at ×. The junction of the central canal in the penis and the T-shaped groove is found much nearer the apex of the penis, and is not shown in the figure; *co. m. c.*, copulatory muscular cushion, the inner wall of the lumen.

Fig. 45. A transverse and sagittal section through the copulatory male pore, showing the ducts. The figure is constructed from three sections. The details are diagrammatic; *pr. d.*, duct from prostate below junction of the diverticle and the main prostate; *pr.*, section of the prostate above its junction with the diverticle. The dotted lines indicate the outlines of the prostate between the two sections; *l. gro.*, lumen of groove running along the exterior of the penis. This groove connects with the lumen of the penis nearer its apex, which is twisted. The section has passed through an apparent, but not a real opening in the wall. A real opening does not exist; *or. y. gl.*, pore of the Y-gland, opposite the external penial groove.

Fig. 46. A more highly magnified detail of fig. 44, representing the pore of the Y-gland and the groove of the penis; *t. gr.*, T-shaped groove in the penis, on the side of the papilla; *c. c.*, copulatory cushion following the inner wall of the bursa; *bu. c.*, copulatory bursa; *o. bu. c.*, opening of copulatory bursa.

Fig. 47. Cross-section of the prostate at the point where the sperm-ducts enter the prostate.

Fig. 48. A cross-section of the body in somite XVII, passing through the pore of the copulatory bursa; *c. b. c.*, cushion of bursa, strongly muscular; *po. b. c.*, pore of bursa, the latter retracted below the outline of the body; *gr.*, exterior groove in penis, cut through in such a way as to appear a single pocket; *d. y. gl.*, duct of Y-gland, near the pore; *or. y. gl.*, pore of Y-gland, the dots indicate its appearance in succeeding sections.

EXPLANATION OF PLATE IX.

Eudrilus Eugeniæ (KINBERG).

Fig. 49. Longitudinal section of the female apparatus, constructed from a number of longitudinal sections of the body; *ov. 2*, posterior ovary in XIII; *ov. 1*, anterior ovary in XIII; *ovd. ov. 2*, oviduct from posterior ovary, connecting at × with the spermatheca; *ovd. ov. 1*, oviduct from anterior ovary.

Fig. 50. A transverse section of the body, constructed from small sections passing through the female apparatus. Letters as in fig. 49.

Figs. 51–54. Lacking.

Ocnerodrilus (Nematogenia) lacuum BEDDARD, *panamaënsis* var. nov.

Fig. 55. A specimen natural size, fixed in formalin.

Fig. 56. The anterior somites, constructed from several longitudinal sections. Details only indicated; *ly. gl.* lymphatic tissue; *i. li.*, inner lips of pharynx.

Fig. 57. Spermatheca.

Fig. 58. Section of the wall of the pouch of the spermatheca, showing the wide terminal pockets of the secreting cells; Zeiss, Apo. 2 mm., Oc. 4.

Fig. 59. Surface view of the two prostates and part of the sperm-ducts, illustrating the muscular and glandular parts, their size and position.

Fig. 60. A dissected prostate, showing copulatory papilla, with pores of sperm-duct and prostate, the former opening posterior to the prostate.

Fig. 61. Surface view of one of the male papillæ, showing the openings of the sperm-ducts and prostates close to each other.

Fig. 62. Detail of a transverse section of the body-wall through the male and prostate pores. The former is dotted.

Fig. 63. Section of the prostate in somite nearest the male pore; muscular and connective tissue layers as well as epithelial glandular cells, with large discharge pockets.

Fig. 64. Section through prostate in the fourth segment from the male pore. Two kinds of glandular cells, some very large, others quite narrow. The latter resemble those found in the glandular part of the prostate. The part through which this section passes does not belong to the glandular part of the prostate, but to the muscular part. The large glandular cells are absent from the strictly glandular part, in which all the cells are columnar and narrow.

Fig. 65. Part of the septal gland in somite VIII, with lymphatic tissue and lymphocytes along the margin; Zeiss D., Oc. 6.

Fig. 66. Lacking.

Fig. 67. Nephridium.

EXPLANATION OF PLATE X.

Benhamia Bolavi MICHAELSEN, *pacifica*, var. nov.

Fig. 68. The ventral sexual zone, showing the fossæ, the prostate pores with penial setæ, and the oviduct pores in the center of XIV.
Fig. 69. A spermatheca, rare form.
Fig. 70. A spermatheca, common form.
Fig. 71. Apex of the longer penial seta.
Fig. 72. Shorter penial seta front view *a;* side views *b* and *c*.
Fig. 73. Section through the junction of the calciferous diverticles with the intestine. The section is tangential to the intestine.

Benhamia Bolavi MICHAELSEN, var. *palmicola* EISEN.

Fig. 74. Section through calciferous diverticle.

Benhamia papillata EISEN.

Fig. 75. Section through calciferous diverticle.

Benhamia nana EISEN.

Fig. 76. Section through calciferous diverticles.

Benhamia papillata EISEN, *hawaiiensis*, var. nov.

Fig. 77. Nephridia in two succeeding somites, showing the outlines of the cœlomic mantles.
Fig. 78. A spermatheca.
Fig. 79. Apex of larger penial seta.

Benhamia papillata EISEN.

Fig. 80. Nephridia of two succeeding somites, showing outlines of the cœlomic mantles.
Fig. 81. Spermatheca.

Dichogaster Crawi, sp. nov.

Fig. 82. A specimen natural size.
Fig. 83. The three anterior somites and prostomium (dorsal view). The very diminutive somite I is entirely hidden between prostomium and somite II. It can be clearly demonstrated in sections only.
Fig. 84. Anterior somites, ventral view. Genital region and the deltoid arrangement of the setæ.
Fig. 85. Genital region, more magnified. The zone is sunk, but the two central papillæ project as high as the body-wall surrounding the zone.
Fig. 86. A more magnified view of one of the genital papillæ, showing the branched deep groove, in the upper end of which open the prostate and sperm-ducts.
Fig. 87. Two of the largest penial setæ, from one sac. The largest seta is more wavy at the apex and the spur is shorter.
Fig. 88. One of the common setæ, showing the general outline *a;* the ornamented apex *b*.
Fig. 89. A spermatheca, the diverticle pointed forwards.
Fig. 90. Two somites on one side of the ventral ganglion, showing the micro-nephridia arranged as four flaps.
Fig. 91. Anterior somites (longitudinal section); corrosive sublimate. Zeiss AA., Oc. 4; *t. c.*, taste-cells in the epithelium. The small, round dots at the base of the narrow epithelial cells represent light-cells *lips*, inner circular lips, with clear sac-like cells. At the anterior end of the lips are seen bunches of taste-cells.
Fig. 92. Longitudinal section of the calciferous diverticles, parallel to the surface of the intestine. The two anterior diverticles are seen to be only folds of one sac, while the posterior diverticle is connected with the former by a narrow ciliated duct, which also serves as a duct for the anterior diverticular folds; *d. c. d.*, duct of calciferous diverticle.
Fig. 93. Longitudinal section passing through the duct of the calciferous diverticle, just cutting into the intestine; *or.*, orifice of diverticles.
Fig. 94. Longitudinal section of the body-wall in the genital somites XVI–XVIII. Genital papilla in XVII, constructed from two sections.

EXPLANATION OF PLATE XI.

Eudrilus Eugeniæ (KINBERG).

Figs. 95–97. Sense-cells from the epidermis of the body-wall representing types of the most common variations of those cells. Figs. 95 and 96 from transverse sections of the body, fig. 97 from longitudinal section. In fig. 95 the narrow ventral protoplasmic diaphragm is contracted, in fig. 96 it is released. In figs. 95 and 96 this diaphragm points diagonally upwards to the right, but it often points to the left. It is never horizontal, nor vertical. The number of marginal cells, *m. c.*, forming the cap varies with the cell.

Pontoscolex corethrurus (FR. MÜLLER), *mexicanus* subsp. nov.

All the figures are drawn with Zeiss Apo., 2 mm., 1.40, Comp. Ocs. 4, 6 and 8, from preparations fixed in corrosive sublimate solution. Benda Iron-hæmatoxylin, Eosin-thionin, or Eosin-toluidine were used in staining.

Fig. 98. Auditory cell supported by two smaller surface cells, which separate it from the cuticle.
Fig. 99. Same.
Fig. 100. Part of the auditory cell in which the archosome (spheres) has the shape of a long sausage-like body. No star-shaped archosome in this cell.
Fig. 101, *a* and *b*. Two auditory cells. The archosomes differ greatly in size. All structures except the archosomes are merely indicated. Oc. 4.
Fig. 102. Part of auditory cell. Two large archosomes, each with two centrosomes. Oc. 8.
Fig. 103. Part of auditory cell, only the archosomes are delineated in detail. They differ greatly in size. Oc. 6.
Fig. 104. Two archosomes from an auditory cell. Oc. 8.
Fig. 105. Two archosomes from an auditory cell, one with two centrosomes, the other with a somosphere and three centrosomes.
Fig. 106. Two archosomes from an auditory cell. In one *(a)* there is a star-like somosphere with centrosome, while *b* has a rounded somosphere with at least two centrosomes. Oc. 4.
Fig. 107. Two archosomes from an auditory cell. One *(a)* has two separate somospheres, one with one centrosome, the other with two centrosomes, connected by a narrow dark-staining band. Oc. 8.
Fig. 108. Two centrosomes from different cells; one stained with Benda iron-hæmatoxylin, the other with eosin-thionin. Oc. 8.
Fig. 109. Part of an auditory cell with two archosomes.
Fig. 110, *a–k*. Amœbocytes from cœlom. Specimen from Tahiti.
Fig. 111. Microcytes from the cœlomic fluid, same specimen as above.

Dichogaster Crawi, sp. nov.

Fig. 112. Lymphocytes from cœlom. *A* and *B* typical forms, which constitute the majority of cells; *C*, *D*, *E*, rare forms for comparison of size with the other cells. *A*, *B*, *C*, Oc. 4; *D*, Oc. 6; *E*, Oc. 8; Zeiss, Apo. 2 mm.; Eosin-Thionin, corrosive sublimate; sections.
Fig. 113. Cells from the prostomium, showing a bunch of common sense-cells, also a single light-cell. Zeiss Apo., 2 mm., Oc. 6.

Ocnerodrilus (Nematogenia) lacuum BEDDARD, *panamaënsis*, var. nov.

Fig. 114. A common mucocyte.
Fig. 115. Several amœbocytes, cover glass preparation.
Fig. 116. Nematocytes; the cytoplasm consists of a single thread coiled like rope. Zeiss 2 mm., Apo., Oc. 8. Sections in paraffin.

Diplocardia Udei EISEN.

Fig. 117. *A*, *B*, lymphocytes; *C*, microcytes.

EXPLANATION OF PLATE XII.

Argilophilus marmoratus collinus, subsp. nov.

Fig. 118. Apex of penial seta.
Fig. 119. Anterior somites, ventral view.
Fig. 120. Genital somites, ventral view.
Fig. 121. Prostomium and somite II.

Argilophilus marmoratus papillifer EISEN.

Fig. 122. Prostomium and anterior somites.

Ocnerodrilus occidentalis EISEN.

Fig. 123. Anterior somites in longitudinal section, showing form and size of septal glands and testes. No details are attempted. The section passes through the centre of the pharyngeal part, but misses the intestine, except at its junction with the diverticle.

Ocnerodrilus occidentalis EISEN, *arizonæ*, var. nov.

Fig. 124. Anterior somites, dorsal view.
Fig. 125. Genital somites, ventral view, showing male pores and papillæ and setæ *ab* in somites XVI and XVII.
Fig. 126. A male papilla with setæ pores.
Fig. 127. The same papilla, side view, inner sac-like lumen, into which open prostate and sperm-duct.
Fig. 128. Outline of prostates and sperm-ducts at the male pore; dissected. The ventral nerve-cord is twice as wide as the sperm-duct.
Fig. 129. Anterior somites, longitudinal section. The details are diagrammatic.
Fig. 130. Cross-section of the male pore; junction of prostate and sperm-duct; slight widening of the sperm-duct near the male pore. No details attempted. Zeiss D., Oc. 2.
Fig. 131. Longitudinal section through the male pore; *sp. d.*, the wider lumem of the two joined sperm-ducts. The fusion of the ducts takes place at the point marked ×; *c. p.*, copulatory papilla.
Fig. 132. One of the testes and sperm-sacs, longitudinal section. The part of the sperm-sacs shown represents about one-half of the whole sac as seen in succeeding sections.
Fig. 133. Section of prostate, showing the two different kinds of cells in the same row or layer.
Fig. 134. Genital zone, longitudinal section in XV and XVI; *gl. c.*, glandular, horizontal cells. The epithelium is chiefly composed of broad, posteriorly frayed cells, the ends of which project through the muscular layers. Probably a sense-zone.

EXPLANATION OF PLATE XIII.

Ocnerodrilus (Ilyogenia) taste (EISEN).

Fig. 135. Spermatheca. This organ is smaller than in the type from El Taste, Baja California. The specimen described is from Tepic, Mexico.

Diplocardia (Aleodrilus) Keyesi (EISEN).

Fig. 136. One of the spermathecæ.

Diplocardia singularis UDE, *caroliniana* var. nov.

Fig. 137. Clitellar and genital somites, ventral view.
Fig. 138. A common seta.
Fig. 139. A penial seta; same magnification as in 138.
Fig. 140. Apex of penial seta.
Fig. 141, *a* and *b*. Two spermathecæ from somites VIII and IX.
Fig. 142. A prostate.

Diplocardia riparia SMITH.

Fig. 143. A spermatheca, somite IX.
Fig. 144. The other spermatheca from the same somite.

Diplocardia Udei EISEN.

Fig. 145. Anterior somites, ventral view. The ventral parts of somites VIII-X are swollen and furnished with spermathecal sexual setæ.
Fig. 146. Sexual zone in somites XVII-XXI.
Fig. 147. Somite VIII, longitudinal section of body-wall, showing spermatheca and its diverticle; *gl.*, glands leading to the spermathecal sexual setæ.
Fig. 148. Spermatheca from IX, with a hidden diverticle.
Fig. 149. A prostate with muscular duct and bundle of penial setæ.
Fig. 150. Spermathecal sexual seta.
Fig. 151. Apex of spermathecal sexual seta; side view and front view.
Fig. 152. Apex of common seta.
Fig. 153. Apex of penial seta, same magnification as fig. 151. Zeiss Apo. 2 mm., Oc. 4.
Fig. 154. Longitudinal section of body-wall passing through the pore of sexual seta and showing the glandular structure combined with it; *sex. gl.*, sexual glands, the ducts of which lead to the pore, and to the chambers opening in the pore; *cham. sex. gl.*, chambers into which open the ducts of the sexual glands; *sex. set.*, sexual seta cut off obliquely, just before it enters the pore; *ducts. sex. gl.*, ducts of the glands leading to the pore.

EXPLANATION OF PLATE XIV.

Ocnerodrilus (Enicmodrilus) tuberculatus, sp. nov.

Fig. 155. Spermatheca.
Fig. 156. The penial tubercle in somite XVII, showing the junction of the sperm-ducts and the prostate.

Ocnerodrilus (Ilyogenia) taste (EISEN).

Fig. 157. One of the spermathecæ. Partly in optical section but showing the irregular swelling at the apex.
Fig. 158. Section of the body-wall passing through the male pore, showing the total absence of prostates.

Ocnerodrilus (Enicmodrilus) mexicanus, sp. nov.

Fig. 159. Spermatheca.

Notiodrilus cristalifer, sp. nov.

Fig. 160. Spermatheca.
Fig. 161. The longer penial seta.
Fig. 162. The apex of the shorter penial seta.

Notiodrilus Whitmani, sp. nov.

Fig. 163. The prostate and the sacs of penial setæ.
Fig. 163*a*. Apex of a penial setæ.
Figs. 164, 165. The two anterior spermathecæ.
Figs. 166, 167. The two anterior spermathecæ from the same specimen as the last.

Benhamia jamaicæ, sp. nov.

Fig. 168. Spermatheca.
Fig. 169. Apex of two penial setæ from the same sac.

Benhamia papillata EISEN, *hawaiiensis*, var. nov.

Fig. 170. A spermatheca.
Fig. 171. Another spermatheca from the same specimen as the last.

Benhamia guatemalæ, sp. nov.

Fig. 172. Spermatheca.
Fig. 173. Another spermatheca from the same specimen as the last.
Fig. 174. Apex of a penial setæ.

Benhamia viridis, sp. nov.

Figs. 175, 176. Two spermathecæ. The former from a specimen from the city of Mexico, the latter from Morelos.

Diplocardia (Naillenia) Koebeli, sp. nov.

Fig. 177. Apex from two penial setæ.
Fig. 178. Spermatheca showing the short and broad diverticle with pockets of spermatozoa.

Trigaster tolteca, sp. nov.

Fig. 179. Spermatheca. The small dots in the rounded chambers represent the nuclei of glandular cells.

Zapotecia ameca-mecæ, gen. et sp. nov.

Fig. 180. Spermatheca. The lower part which serves as diverticle contains many small pockets for spermatozoa.

Dichogaster Ribaucourti, sp. nov.

Fig. 181. Spermatheca. The dots in the round chambers represent the nuclei of the cells which compose the peculiar glandular structure of the inner lining of the organ.

Dichogaster Townsendi, sp. nov.

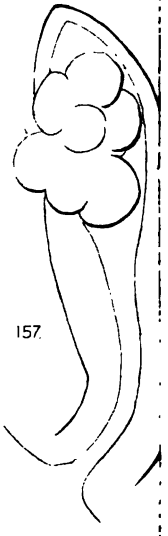
Fig. 182. Spermatheca. The sac is unusually thin-walled.

Microscolex parvus, sp. nov.

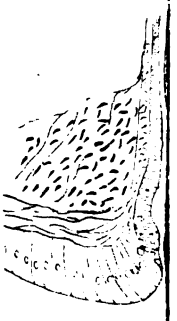
Fig. 183. Spermatheca, showing the two diverticles.
Fig. 184. Prostate with sperm-ducts.

Microscolex Horsti, sp. nov.

Fig. 185. Spermatheca.



157.



159.